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NOVEMBER 15, 1942

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AUTOMOTIVE and Aviation INDUSTRIES

Published Semi-Monthly

Volume 87 | November 15, 1942 | Number 10

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Cable Address ..... Autoland, Philadelphia

Member of the Audit Bureau of Circulations
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AUTOMOTIVE and AVIATION INDUSTRIES is a consolidation of the Automobile (monthly) and the Motor Review (weekly), May, 1902; Dealer and Repairman (monthly), October, 1903; the Automobile Magazine (monthly), July, 1907, and the Horseless Age (weekly), founded in 1895, May, 1918.

Owned and Published by

CHILTON COMPANY
(Incorporated)

Executive Offices
Chestnut and 56th Streets, Philadelphia, Pa., U. S. A.

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AUTOMOTIVE and AVIATION INDUSTRIES. Vol. 87, No. 10. Published semi-monthly by Chilton Co., Chestnut & 56th Sts., Phila. Entered as Second Class Matter October 1, 1925, at the Post Office at Philadelphia, Pa.; Under the Act of Congress of March 3, 1879. In case of Non-Delivery Return Postage Guaranteed. Subscription price: United States, Mexico, United States Possessions, and all Latin-American countries, $1.00 per year. Canadian and Foreign $2.00 per year; single copies, 25 cents, except Statistical Issue (Mar. 15, 1942), 50 cents.

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IN THIS ISSUE . . . .

AUTOMOTIVE and AVIATION INDUSTRIES

Volume 87 November 15, 1942 Number 10

AUTOMOTIVE INDUSTRIES

Reg. U. S. Pat. Off.

Living Costs Up 0.9 Per Cent in October

The cost of living for wage earners and lower-salaried clerical workers in the United States continued its upward trend in October with a rise of 0.9 per cent, according to the Division of Industrial Economics of the National Industrial Conference Board.

Food costs again accounted for the increase, jumping 2.5 per cent during the month. Both clothing and sundries made a slight rise of 0.1 per cent, while housing and fuel and light remained at the level of the previous month.

The Board's index of the cost of living (1923 = 100) stood at 99.5 for October as compared with 98.6 in September, 98.1 in August, 97.8 in July, 97.3 in both May and June, 92.0 in October, 1941, and 86.0 in January, 1941.

The level of living costs was 8.2 per cent higher than that of a year ago. Food showed the greatest advance over October, 1941, with an increase of 16.2 per cent. Other advances during the twelve months were: clothing, 13.0 per cent; sundries, 3.3 per cent; housing, 1.8 per cent; and fuel and light, 0.6 per cent.

The purchasing value of the 1923 dollar amounted to 100.5 cents in October, 101.4 cents in September, and 108.7 cents a year ago.

AUTOMOTIVE and AVIATION INDUSTRIES

Published on the 1st and 15th of the month

Vol. 87, No. 10
November 15, 1942

32 Million Motor Vehicles Registered in 1942

By Marcus Ainsworth

IN SPITE of the fact that the production of new civilian automobiles was stopped February 11th and trucks on May 31st, in spite of any excess over the normal annual scrapping of 2,500,000 motor vehicles, in spite of the rubber and gasoline situations which have been acute since the first of this year, total registrations of motor vehicles in the United States for 1942 will reach nearly 32,000,000. Thus there is demonstrated again and forceably the importance of the automobile to the national economy.

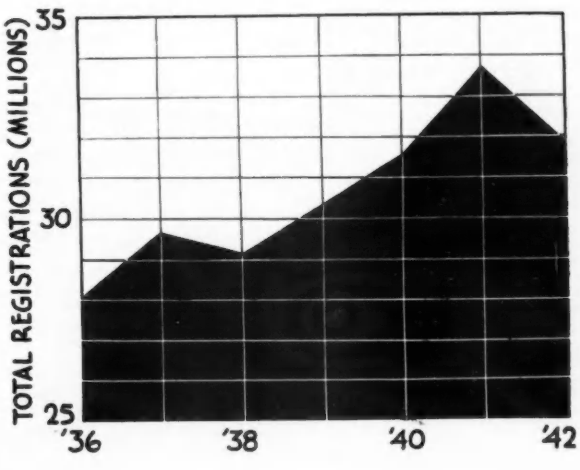
An actual count to the latest available date and a careful estimate of registrations for the remaining period of the year indicates that total vehicle registrations will be approximately 31,944,764. Of this number 27,387,606 will be passenger cars and taxicabs and the remainder 4,557,158 will be trucks and buses. Passenger cars will show a decline of 1,451,113 units or about 5.2 per cent from the 28,838,719 registered by the end of 1941 while trucks and buses combined will have declined 300,092 units or 5.7 per cent from the 4,857,250 registered during the same period last year. While this indicates a total loss of 1,751,205 vehicles or about 5.3 per cent from the 33,695,969 vehicles registered during 1941, nevertheless the 1942 registration will still be in excess of total registrations during 1940 when the count was 31,566,324 motor vehicles.

When it is considered that practically no new cars or trucks were registered during the calendar year and that an average of over 2,500,000 vehicles are scrapped each year, total registrations have held up to a remarkable degree. From 1937 through 1941 inclusive there was a yearly average of 3,035,000 new cars and 537,000 new trucks registered, with total new vehicle registrations averaging yearly 3,572,000 units. These combined with the normal scrappage indicate a normal decline of approximately 6,072,000 vehicles during 1942 provided no heretofore idle used cars were brought into service and registered. However, there is every indication that used car sales must have been good in many sections of the country in order to hold the decline in total vehicle registrations to the forecast of 1,766,829 units instead of to the indicated decline of 6,072,000.

To those that have not studied the motor vehicle registration situation very carefully this decline in total registration must seem rather small. They will argue that gasoline rationing throughout the eastern seaboard states and the inability to secure new tires throughout the country must have forced a greater number of vehicles than is indicated off the road. However, it must be borne in mind that the great bulk of these registrations for 1942 went into effect before gasoline rationing was anymore than talked about and while owners were somewhat aware of the tire situation, the acute shortage of rubber had not yet been brought to their attention.

Twenty-four states start their registration period the first of the year, four on March first, fourteen on April first and the remainder at various times throughout the year. West Virginia has its registration period from July first to June 30th of each year. All the other states therefore started their registration year

Seven Years of Motor Vehicle Registrations in U. S.



several months before the motoring public was made acutely aware of the critical situation as regards tires and the necessity for gasoline rationing. The great bulk of registrations is usually made during the early days of the registration period.

Because of the preponderance of states that start their registration periods sometime during the first three months of the year, it is recognized that this forecast of total motor vehicle registrations as of the end of 1942 may not be quite as accurate a picture of motor vehicles in use as it has been in the past. In previous years the elimination of duplicate registrations alone would give the true story of vehicles in use. This year, such is not the case. Many owners after registering their cars found the stringent gasoline rationing too much for them and therefore discontinued the use of their cars or disposed of them. Other cars have been forced off the road due to inadequate rubber and inability to secure new tires. Government regulations have forced some taxicabs off the streets and further O.D.T. regulations for fleet owners to save mileage have been the occasion for taking many of their trucks off the road and placing them in storage. Car pooling has no doubt added further cause to the curtailment of passenger car use. It is impossible to give an estimate of the actual number of vehicles that may have gone out of service since they were originally registered in 1942. It is to be expected that a further drop, of unpredictable size, in total registrations will be found at the end of the coming year.

What the full effect of governmental restrictions and other factors may be is perhaps indicated by returns for 1942 from the state of West Virginia, which starts its registration period on July 1st. By that date of this year the West Virginia private car owners knew for certain that they would be restricted in their purchases of gasoline; they believed that new tires were out for the duration so far as the majority of them were concerned and they also knew that their automotive taxes were to be increased rather than decreased. As a result possibly, of this more comprehensive knowledge of the situation by vehicle owners, total registrations in West Virginia will have dropped 19 per cent from that of the previous fiscal year, the greatest percentage decrease in registrations of any state in the country. It is anyone's guess as to whether this story will be amplified to include the whole country by the end of 1943 or whether the many possible counter-balancing factors which now exist or may develop will have sufficient effect to keep the national registrations total from decreasing to a like extent. One important and, in fact, predominent influence among the counteracting factors is the altered attitude of the Administration, since the Baruch report, toward motor vehicle transportation.

Closely allied with registrations of motor vehicles are the state taxes that result from the sale of gasoline and from registration fees. Due largely to the restriction on the sales of gasoline along the eastern seaboard and the voluntary reduction in miles of driving throughout the rest of the country, state gasoline taxes will have a decrease from those collected last year of about 17 per cent. State gasoline tax receipts will be approximately $789,000,000 as compared with $951,000,000 for 1941. Registration fees and operators licenses exclusive of any special state usage taxes will approximate $446,000,000 as against $490,700,000 during 1941, a drop of about 9 per cent from the 1941 figure.

We feel that the estimate, here presented, of total registrations as of the end of this year will be a very close approximation to the final figures for the various states and the country at large which will be published in the 1943 Statistical Issue of AUTOMOTIVE *and* AVIATION INDUSTRIES. This forecast has been made for several years past through the cooperation of the motor vehicle commissioners of all the states. From them are secured actual registrations to the nearest available date and their estimate of the returns for the remaining portion of the year. Forty-six states sent us their returns. Last year total registrations were estimated to be 33,681,499 cars and trucks and final returns

(Turn to page 66, please)

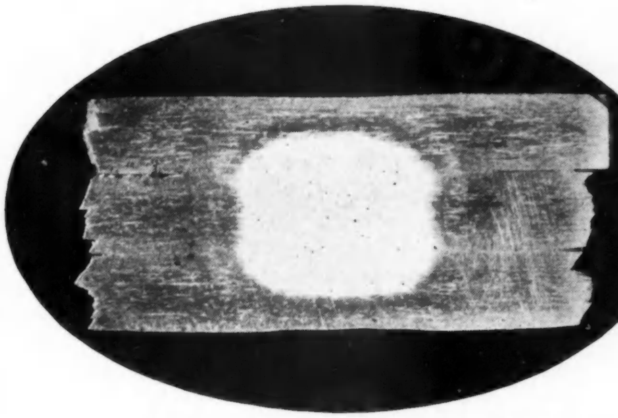
Forecast of 1942 Total Motor Vehicle Registrations

	Passenger Cars		Trucks and Buses		Total Motor Vehicles	
	1942	1941	1942	1941	1942	1941
Alabama	292,500	291,379	64,800	66,680	357,300	358,059
Arizona	115,130	117,377	26,350	27,024	141,480	144,401
Arkansas	206,500	229,978	74,800	84,000	281,300	313,978
California	2,436,402	2,518,697	349,627	350,261	2,786,029	2,868,958
Colorado	316,500	336,702	30,000	31,044	346,500	367,746
Connecticut	457,212	463,003	56,155	81,862	513,367	544,865
Delaware	57,840	64,662	13,904	12,180	71,744	76,842
Dist. of Columbia	157,000	154,333	16,000	15,194	173,000	169,527
Florida	422,827	466,199	89,000	89,235	511,827	555,434
Georgia	437,000	457,782	99,000	103,409	536,000	561,191
Idaho	122,383	134,377	34,744	36,654	157,127	171,031
Illinois	1,730,750	1,825,142	230,600	234,703	1,961,350	2,059,845
Indiana	930,000	929,115	136,000	137,404	1,066,000	1,066,519
Iowa	654,256	712,584	101,500	108,985	755,756	821,569
Kansas	500,000	503,921	116,000	113,872	616,000	617,793
Kentucky	380,000	414,845	76,000	82,582	456,000	497,427
Louisiana	345,000	350,615	84,000	93,305	429,000	443,920
Maine	154,000	172,832	42,500	45,533	196,500	218,365
Maryland	410,782	428,764	61,358	65,377	472,140	494,141
Massachusetts	811,000	845,874	116,350	115,765	927,350	961,639
Michigan	1,221,369	1,144,551	101,530	129,589	1,322,899	1,274,140
Minnesota	722,800	772,932	123,945	129,992	846,745	902,924
Mississippi	200,000	202,624	60,000	64,119	260,000	266,743
Missouri	780,000	820,080	152,000	164,546	932,000	984,628
Montana	180,000	147,256	46,000	51,476	226,000	198,732
Nebraska	303,100	354,903	63,661	71,665	366,761	426,565
Nevada	38,975	27,736	9,864	6,843	48,839	34,579
New Hampshire	96,100	109,971	25,277	32,433	121,377	142,404
New Jersey	941,635	1,008,370	142,205	145,617	1,083,840	1,153,987
New Mexico	85,067	98,251	28,579	31,620	113,646	129,871
New York	2,218,300	2,506,472	316,125	354,440	2,534,425	2,860,912
North Carolina	524,705	558,499	95,995	97,660	620,700	656,159
North Dakota	142,483	152,020	41,978	40,899	184,461	192,919
Ohio	1,875,000	1,800,000	160,000	196,000	2,035,000	1,996,000
Oklahoma	442,646	478,348	110,000	77,395	552,646	555,743
Oregon	345,000	353,213	77,650	76,227	422,650	429,440
Pennsylvania	1,868,900	1,999,868	283,304	281,439	2,152,204	2,281,307
Rhode Island	168,237	174,045	22,608	21,659	190,845	195,704
South Carolina	293,500	313,731	47,800	50,638	341,300	364,369
South Dakota	165,000	167,590	33,000	35,093	198,000	202,653
Tennessee	370,000	427,961	72,500	81,022	442,500	508,963
Texas	1,320,200	1,440,996	301,550	369,865	1,621,750	1,810,861
Utah	134,357	125,796	26,409	24,745	160,766	150,541
Vermont	75,500	87,048	9,640	10,438	85,140	97,486
Virginia	454,200	468,667	84,500	84,713	538,700	553,380
Washington	516,800	520,599	92,750	96,431	609,550	617,030
West Virginia	221,650	279,700	48,500	56,140	270,150	335,840
Wisconsin	680,000	807,810	140,900	159,003	820,900	966,813
Wyoming	65,000	71,501	20,200	20,474	85,200	91,975
Totals	27,387,606	28,838,719	4,557,158	4,857,250	31,944,764	33,695,969

Some Aircraft Production Problems

Solved by Process Engineering

By T. E. Piper*



Magnesium Spotweld having total thickness of .480 in. This spotweld nugget has a shear strength of over two tons.

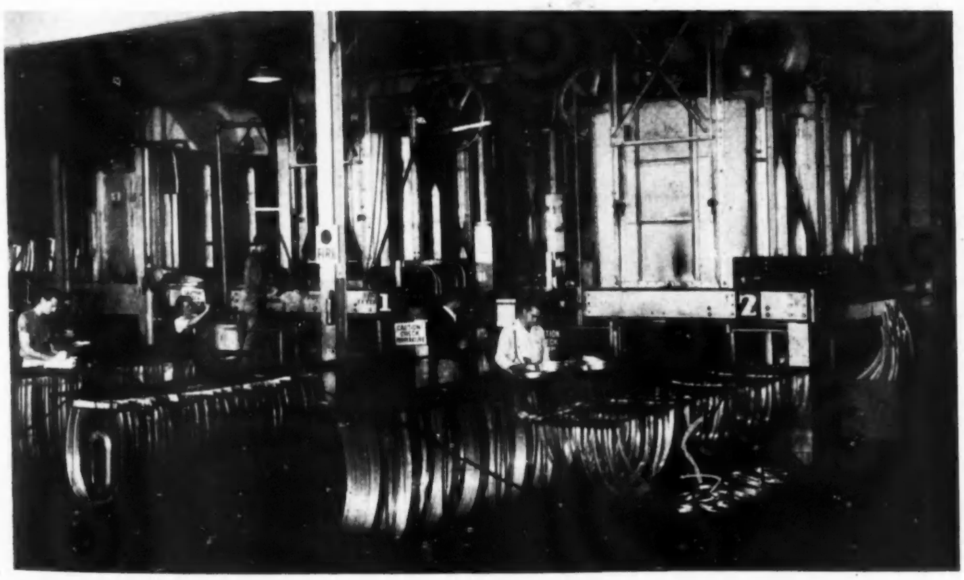
MODERN process engineering was unknown in the aircraft industry during World War I and struck its stride only with the advent of the low-wing all-metal monoplane. The use of duraluminum was a new departure for the industry and confronted it with new problems. Process engineering had to discover the limitations of the material, the best methods of working it, and the best means of protecting it against fatigue and corrosion. Today we are working with magnsium alloys in the same pioneering way as we were with dural ten years ago. Research along this line is being accelerated under the pressure of the present emergency, which is calling for faster, stronger and lighter aircraft.

In aircraft production, process engineering fulfills a dual function: It must make sure that the material employed is of good quality, and it must specify the proper processes for working it, and finishes which will prevent its corrosion. A closer check on material is required than ever bfore, because manufacturers of materials, in their endeavor to meet war demands, have changed their manufacturing methods to expedite production. In some instances they have made substitutions in alloying ingredients which result in imperfect material or material having quite different processing characteristics from that formerly used. An example of this is SAE 1020 steel, commonly known as cold-rolled steel, which is the simplest steel to produce. It is now impossible to obtain this steel without imperfections either in the form of entrapped oxides which cause fissures, or an excessive amount of some undesirable impurity such as sulfur, which impairs its welding qualities. On one contract we were obliged to discontinue SAE 1020 steel and substitute one which is more difficult to use, and therefore more expensive.

Another example is duraluminum sheet material used extensively in aircraft construction. Increase in production has resulted in a material which is finer grained, with a satin finish. This is actually a stronger sheet, but we are encountering difficulty in its processing. Because of its finer grain structure, the "creep," or heat-treat warpage properties have increased, and changes therefore must be made in heat-treat procedures. It is the alloying of aluminum with copper in dural that gives it the heat-treating property and the strength required for structural members. This heat-treating process consists in heating in an air furnace to approximately 930 deg. F. and chilling by a water quench. This chilling holds the copper and other alloying elements in solution and prevents them from precipitating to the grain boundaries, which would cause inter-

(*Turn to page* 68 *please*)

* Process Engineer, Northrop Aircraft, Inc.



This aluminum heat-treating furnace mounted over quenching tank reduces time of dropping load into water bath to less than four seconds. Northrop engineers designed it to help minimize intergranular oxidation.

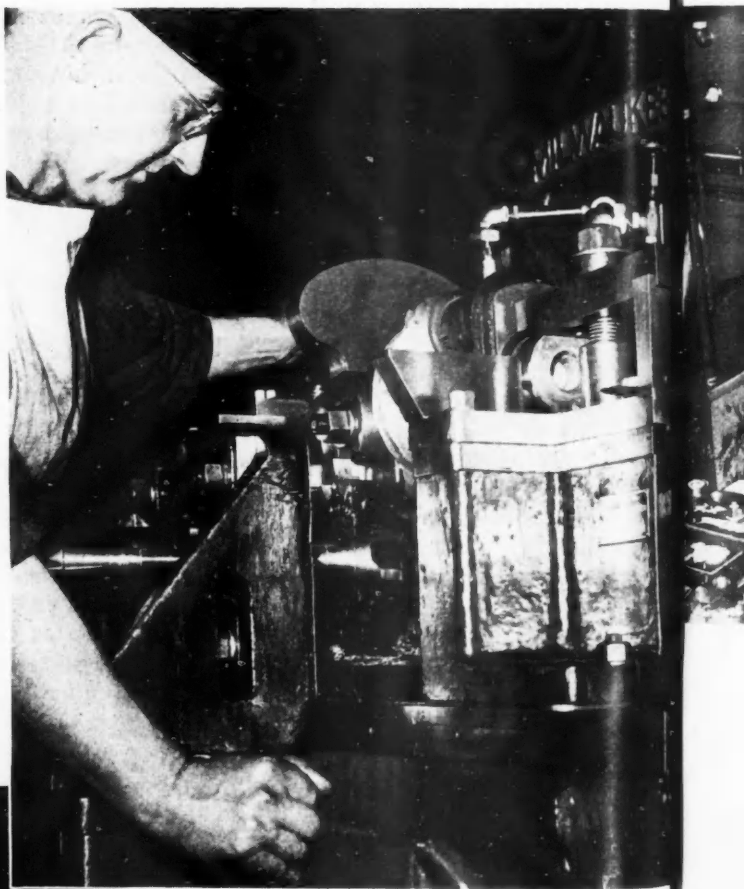
BUICK'S KNOW HOW S

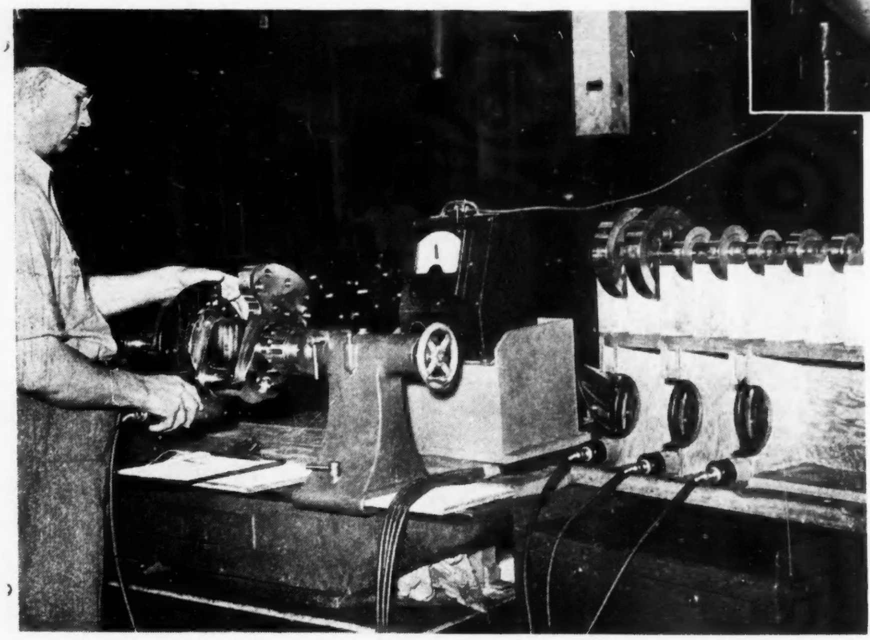
Production of A

By Joseph Geschelin

OUTSTANDING as an example of complete conversion from motor cars to war production is found in the case of the Buick Motor Division, General Motors Corp., now engaged in the manufacture of airplane engines and parts. The airplane engine parts activity is carried on in buildings formerly equipped for the production of passenger cars; one building in particular is well-known to friends of Buick as the home of the Buick engine. In each case, all of the original equipment has been cleared away to make room for the modern and, in some instances, specialized equipment required for the job at hand.

What with increasing engine requirements, the volume of parts production has been accelerated to such an extent as to justify the segregation of each part in a separate department, equipped with the latest types of machinery and laid out for mass production. Perhaps the best evidence of mass production methods is found in the planning for materials handling. Inter-departmental transportation is handled by a fleet of Automatic Transportation industrial trucks. Latest development is the installation of an overhead monorail conveyor system in the master and articulated rod department, designed to facilitate the movement of parts from one





(Above) Another outstanding milling operation is this Milwaukee mill tooled for the profiling—by form milling—of the crank pin top surfaces.

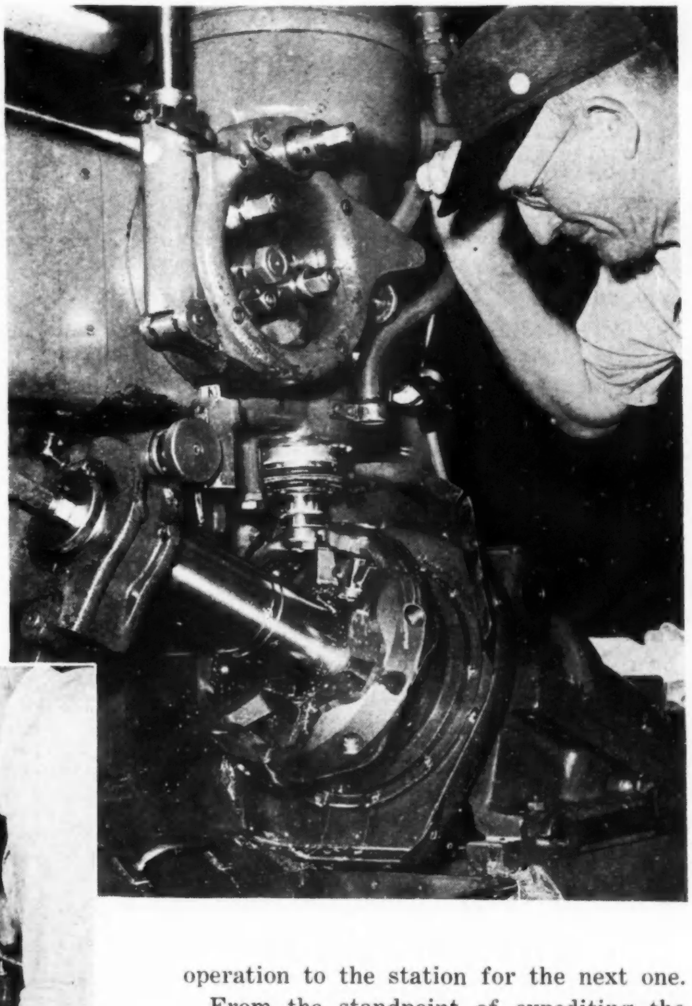
(Left) Pratt & Whitney Electrolimit equipment does an outstanding job of checking the cylindrical surfaces of the crankshaft to exceptionally close limits.

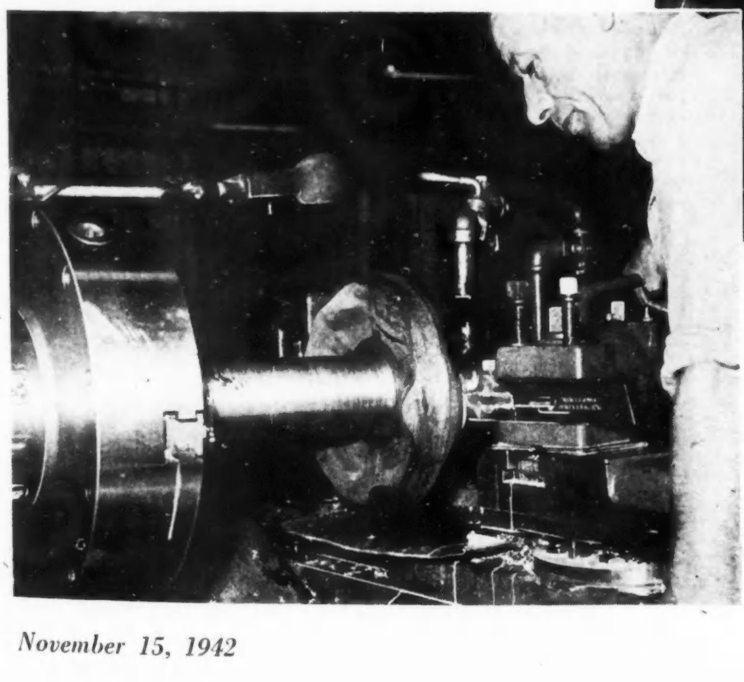
(Right) A massive Monarch lathe with a Keller automatic tracer attachment does a remarkable job of turning three different surfaces on the rim of the propeller shaft.

Speeds Airplane Engine Parts

(Above) This four-spindle Cincinnati Hydrotel, in the connecting rod department, does the profiling of the channel in the link rods. Note the heavy fixture, holding eight link rods at time.

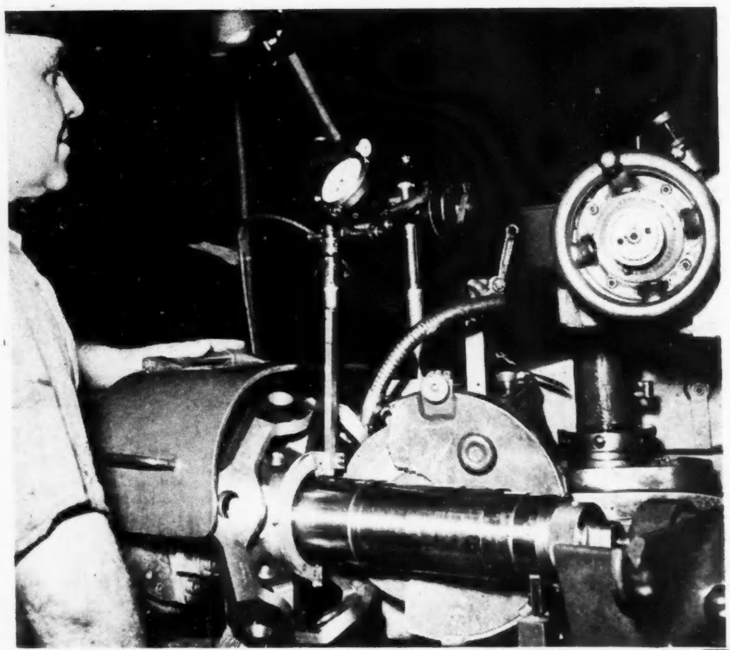
(Below) Unusual application is this Fellows high-speed gear shaper, adapted for the shaping of scallops on the sides of the propeller shaft rim. This operation is repeated separately for each side.





operation to the station for the next one.

From the standpoint of expediting the war effort, Buick provides an excellent example of the most practical application of the automotive "know-how." In the initial stages of the airplane engine program, Buick had to start as does everyone else, by accepting the standardized procedure developed by the engine builders, using the same methods and, in general, similar



Landis special angular head grinder form-grinds the surface between the rim and the shaft section of the propeller shaft.

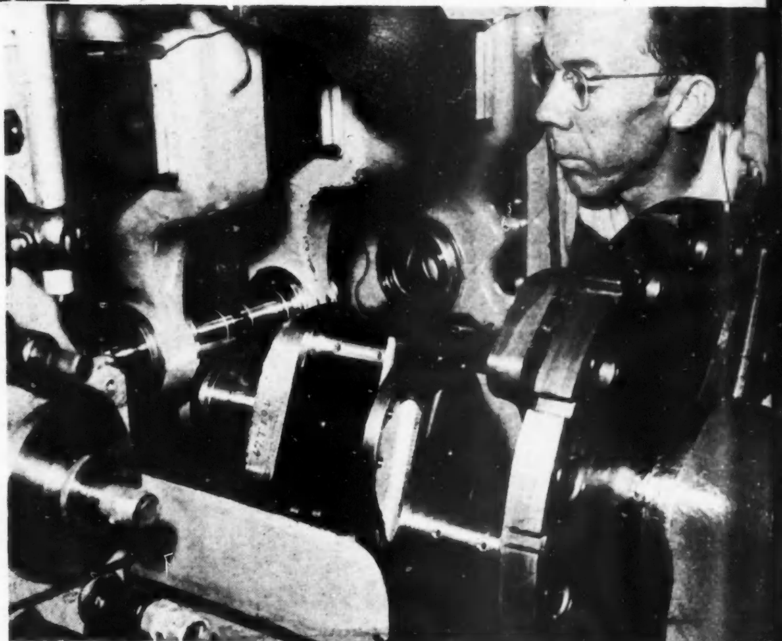
equipment. However, with the impetus of increasing volume and the accumulated experience that came with initial production the management began to analyze each individual operation and began to form the groundwork for improved methods.

Today Buick has found it possible to introduce many new techniques which have served to improve quality and step up the pace of production. In some instances, this process has been accompanied by the adoption of new types of machines; in other instances, this procedure has made it possible to eliminate items of equipment formerly recommended for specific operations. Net effect of this activity has been to release machines on hand for duties in other departments or to other plants; in still other cases, it has made it possible to cancel certain critical machines on order. The most striking thing about it is that invariably one or two of the new machines introduced by Buick have replaced a larger number of conventional machines, releasing not only the machines but skilled operators as well.

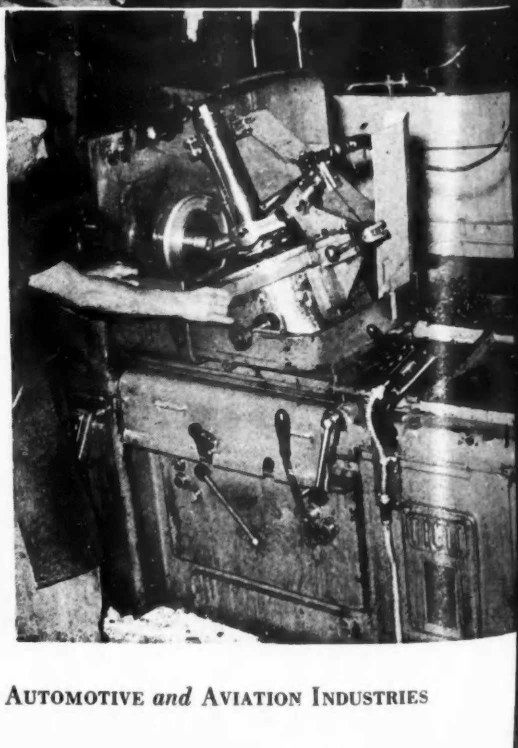
Even a cursory examination of the airplane engine parts division highlights many features worth special mention at this point. For one thing, quality control is emphasized at every turn, safeguarded not only by careful inspection but by painstaking attention to detail, right down to the design of the massive fixtures. Heavy metal removal, characteristic of airplane fabrication, is very much in evidence. This accounts for the multiplicity of set-ups and for the numerous heat treating operations designed to relieve the pent up strains imposed by massive metal removal.

Among the new techniques adopted here is the substitution of form-milling for the slower method of shaping; also as a substitute for the costly and time-consuming method of surface grinding. Noteworthy, too, is evidence of many applications of "rocker" grinding operation in the crankshaft department. Here the grinders have been fitted with special "rocker" attachments for grinding partial radial surfaces, sometimes inaccessible due to interferences. Some of the attachments operate with an automatic cycle; others are hand-operated.

Propeller shafts have a complex three-plane surface which has to be accurately formed on the outside of the rim. These operations are handled on big Monarch lathes fitted with Keller automatic tracer attachment. Unusual is the adoption of Fellows high-speed gear shapers forming the contour of master and

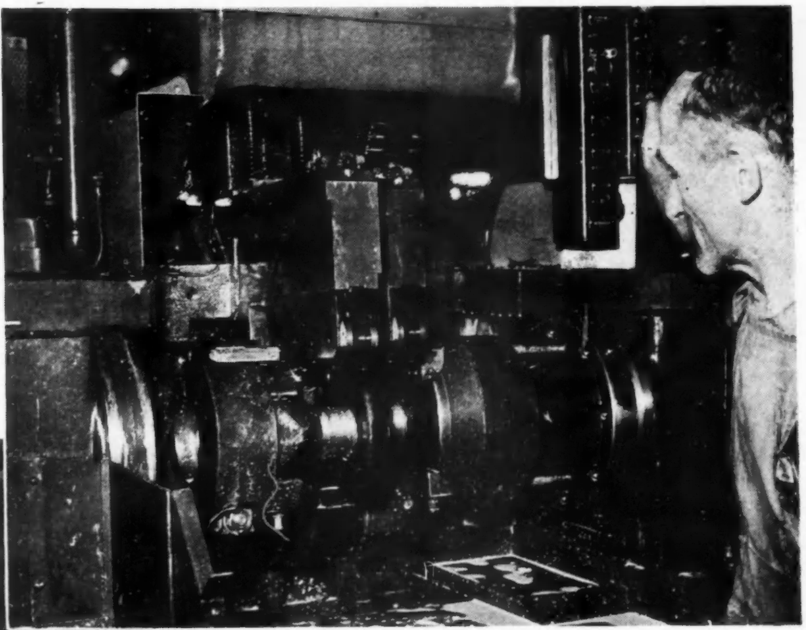


(Above) Close-up of a Sundstrand Rigidmil set up for cutting the spline end of the crankshaft. A similar machine is found on the propeller shaft line.

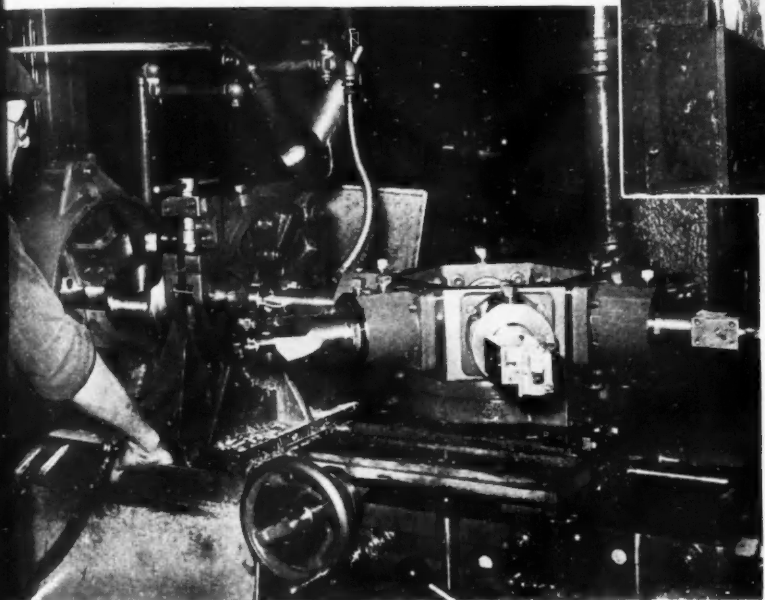


(Right) Close-up of a Heald Bore-Matic for precision-boring the holes in the outer and inner sections of the rim.

link rods ends. Crankshaft and propeller shaft splines are cut on Sundstrand Rigid-Mils. Threaded sections are precision-ground from the solid diameter on Ex-Cell-O thread grinders. Andrew C. Campbell abrasive cut-off saws are found here on the crankshaft and on the propeller shaft lines. In each case the cut-off saw is employed to remove a heavy coupon and thin disc from the end of the forging. These saws handle the work



Crankshaft Machine Co., massive automatic crankshaft turning machine, roughing pins and webs on the two-throw crankshaft.



This Gisholt, one of a battery of such machines, is finish-machining one end of the crankshaft bore.

in excellent fashion and with unusual speed.

Various types of milling machines constitute a major part of the metal cutting facilities. Among these are numerous items of Cincinnati Hydro-Tels, Cincinnati Hydromatics, Cincinnati Duplex and Simplex mills, Sundstrand, and Kearney & Trecker milling machines of various types.

Carboloy is used principally in precision boring on Heald Bore-Matics. An interesting innovation is the drilling of oil holes in the hardened crankshafts, using the newly developed Detroit Black drills which penetrate the hardened surface with a countersink. This expedient not only has speeded up production many times, but has eliminated rejections as well.

Barnes Drill Co. honing machines fitted with Micromatic hones are used for finishing con rod bores. A large battery of heavy-duty Barnes drills and Barnes Hydram machines are in evidence on other operations. Norton grinders of every variety dominate the view in the crankshaft and propeller shaft departments. In addition to the Surface grinders, there are numerous Norton Crank-O-Matics and Crank-O-Pin grinders.

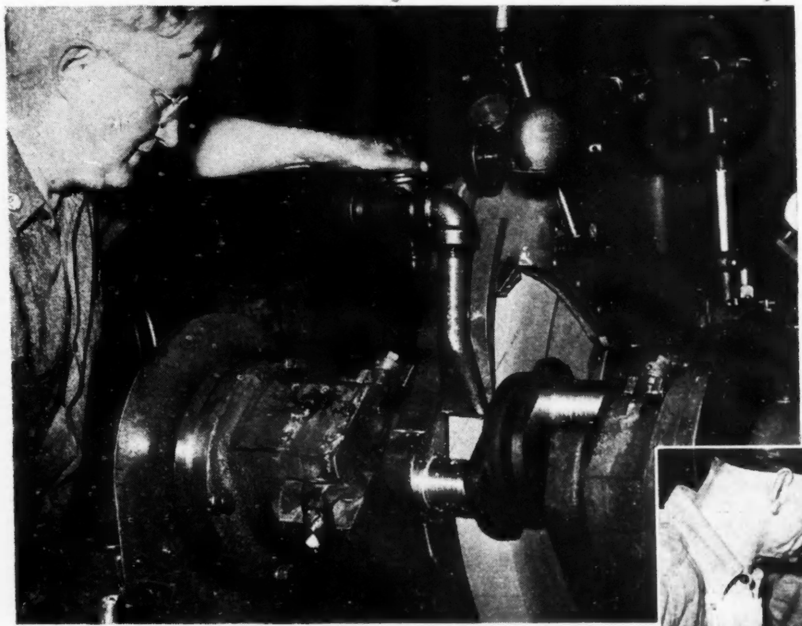
Here, too, are Sundstrand automatic lathes and Gisholt turret lathes. A battery of three W. F. & John Barnes horizontal two-spindle machines is used for core-drilling the long bore in the propeller shaft. Latest and largest of the Bryant chucking grinders are found in the propeller shaft department and in the master and link rod departments. Perhaps the most unusual of these is the Bryant internal grinder used to finish-grind a taper bore in the propeller shaft. This is done with a special taper attachment.

Heat treating equipment is dominated by new furnaces supplied by the Surface Combustion Co. Detroit Rex solvent degreasers are employed for a variety of metal cleaning operations—following heat treating, between metal cutting operations, and in preparation for inspection.

With this background let us examine a few of the highlights of the manufacturing procedures in the airplane parts division. Consider the crankshaft. The rough forging comes in at about 196 lb, goes into the engine at 90 lb, representing metal removal of around 55 per cent. Despite this drastic metal removal, and the multiplicity of metal cutting and heat treating operations, no straightening of the shaft is permitted. This places the burden of precise alignment on a series of corrective operations which take advantage of the excess stock allowed between operations to provide some leeway for the corrective steps.

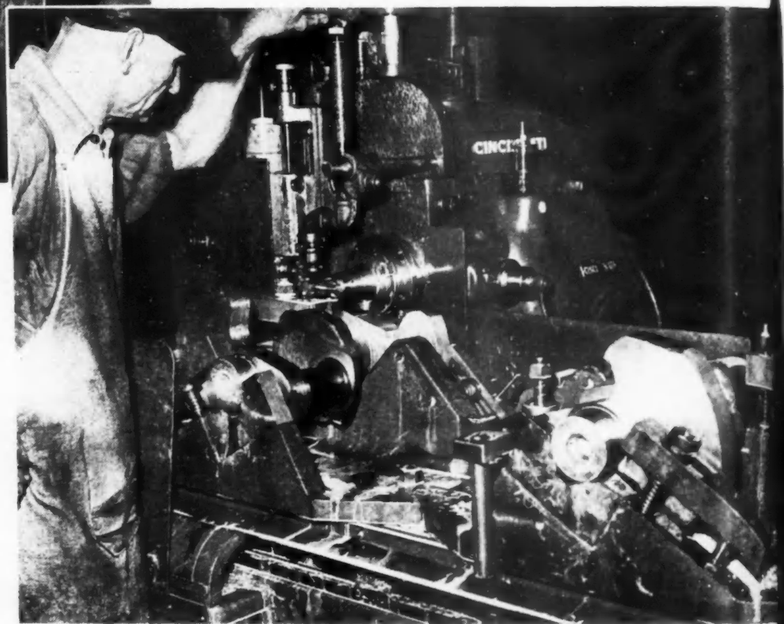
Crankshaft forgings as presented to the machine shop have been suitably heat treated, subjected to metallurgical inspection, and centered. The machine shop routine involves so many hundreds of steps that we shall content ourselves with but a sampling of some of the major operations.

It is of interest to note that the routing of the shaft



(Left) One of a battery of Norton Crankomatic grinders, this one set up for the grinding of crank pins.

(Below) Excellent example of carefully planned milling for maximum productivity. This is a Cincinnati Hydromatic tooled for the profiling of crank cheeks. Note the massive fixture holding two shafts at a time.

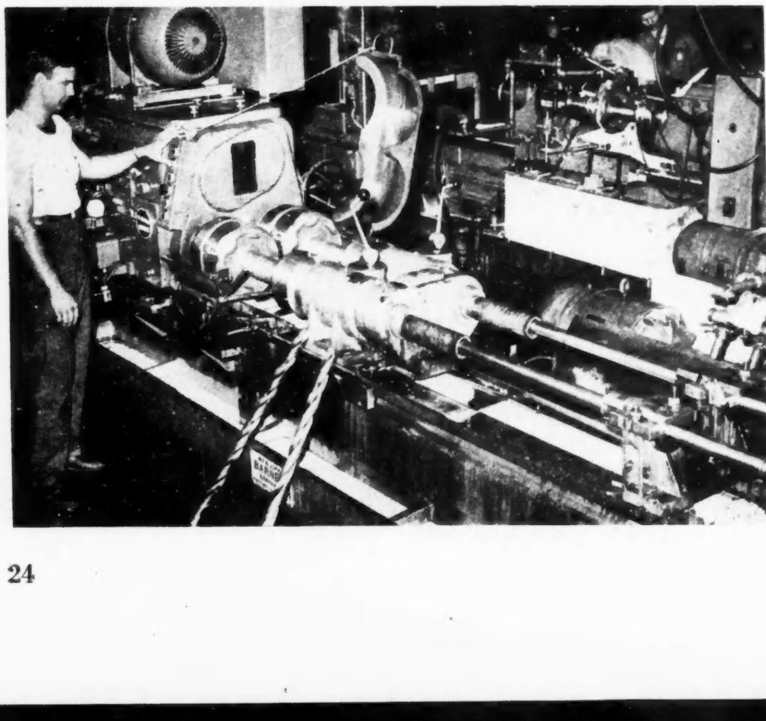


has been divided into a number of distinct stages, each of which represents a separate phase of the operation. Thus, for example, there are the initial rough machining operations, preceding carburizing and heat treatment. This phase prepares the shaft for case carburizing, leaving sufficient stock for subsequent operations. Then there is the semi-finish machining stage in which the shafts are prepared for hardening and final grinding. Here, the metal removal process is further continued, preparing the way for final grinding. The finishing stages are quite extensive, including finish grinding, as well as the many operations following the assembly of counterweights.

Basic operation is that of milling two locating spots, using a 3-K vertical Milwaukee Mil. Then end main bearings and shoulders are rough turned in a Wickes center drive crankshaft lathe. A special test coupon and test slug now are cut off on the Campbell Cutomatic. These test pieces are suitably stamped, follow each shaft through all of the succeeding operations, leave a permanent metallurigical record of each shaft that flies.

The shaft then proceeds through various steps such as re-centering of the front end, grinding front and rear main bearings on Norton grinders, rough turning and grinding of pins, etc. This completes the rough machining cycle. The work then goes to the heat treat for carburizing in Surface Combustion furnaces to produce a depth case of 0.070 in. minimum.

On a Gisholt 2-L turret lathe, the shaft ends are faced and re-centered leaving stock for subsequent turning and grinding. This is followed by turning of main bearings on Wickes lathes, grinding on Nortons, rough-milling of counterweight ends on Cincinnati Duplex Hydromatics. Counterweight contours are milled on Cin-



This special W. F. & John Barnes horizontal drilling machine takes care of the core-drilling through the propeller shaft.

cinnati tracer-controlled milling machines. Then follow form-milling on the pin tops and the ends of pins in Kearney & Trecker Simplex mills.

Allowing for other operations too numerous to mention, the foregoing carries the shafts through the semi-finish machining stage, prepares them for hardening. For this purpose, they are fitted in special fixtures which aid in minimizing fire distortion, are heated to 1475 F for four hours in a General Electric box type furnace, then are water-quenched, drawn at 450 F for four hours in batch-type draw furnaces. Then the shafts are sandblasted in a Pangborn 6-ft rotary table cabinet, subjected to metallurgical inspection, and are ready for the finishing stages.

Once again the ends are re-centered and lined up, and the shafts are routed over an extensive line-up of finish, turning, grinding, drilling, and other types of operations. Drilling operations are unique, include the preparation of a multiplicity of oil holes. It is of interest to note that all holes, including the oil holes, are drilled, reamed, and polished.

Main holes in the front and rear ends are bored on 2-L Gisholt turret lathes. In final grinding, pin diameters are held to plus or minus 0.0005 in., bearings are held to plus or minus 0.0004 in. Pin grinding is unique, the operation being done on Norton grinders with wheels dressed for plunge cut and with full radius at the ends. The center bearing is held to a tolerance of 0.00075 in. in grinding between the center walls. Bearing and pin surface finish is subject to rigid Profilometer examination. The shafts now are burred and polished, using Thor and Aro tools.

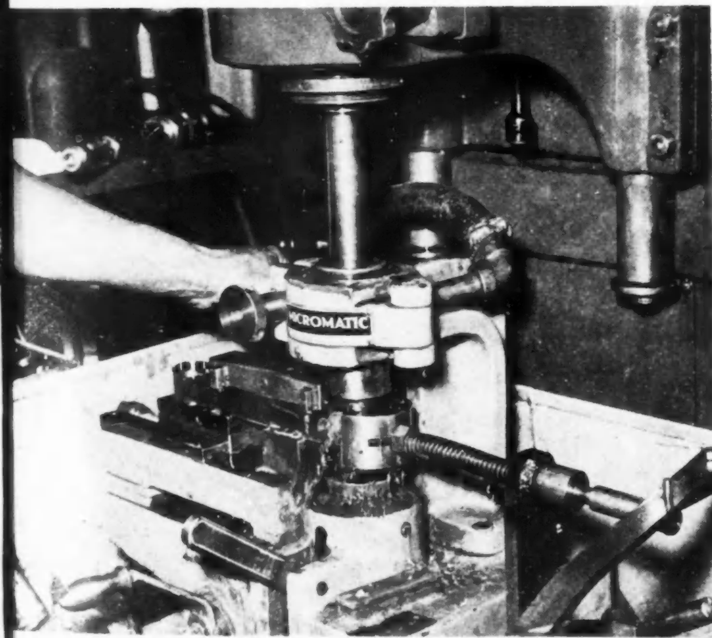
Front and rear centers are ground in Heald 72-A-5 internal grinders, main bearings are ground in Norton Machines, then the shaft is washed in a Blakeslee kerosene washer, followed by Magnaflux inspection. It now goes through a Detroit Rex degreaser and then proceeds through a series of Norton grinding operations, principally on the cheeks.

Among the many other detail operations are—the milling of splines in Sundstrand Rigidmils, grinding of the flyweight hole on a Heald internal grinder, grinding of the thread on the front end in an Ex-Cell-O precision thread grinder. Then a series of polishing, filing and burring operations on all surfaces, using Kellerflex heavy duty machines. The polishing department is fully equipped with Kellerflex equipment, and Aro and Thor pneumatic tools of every variety.

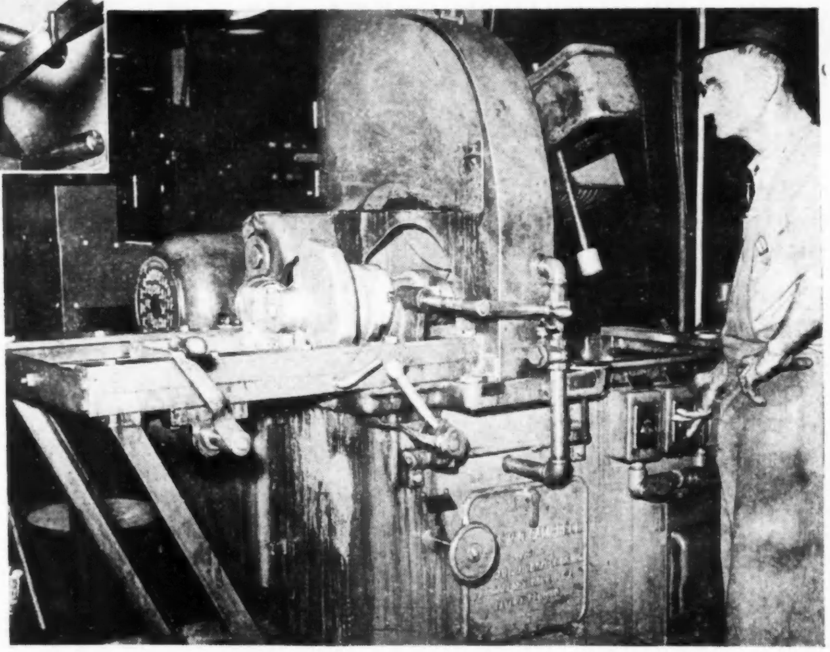
Upon leaving the polishing room, the shafts are washed in a Blakeslee kerosene washer, degreased in a Detrex machine, inspected in the Magnaflux machine, then go through a series of reaming, tapping, and counterboring operations on certain holes. Bearings and pins are lapped to a fine surface finish on a Norton Crank-O-Lap and degreased in a Detrex machine. This is followed by complete inspection, including the use of the Sheffield universal internal gage, Pratt & Whitney Electrolimit snap gages, etc. The shafts now are ready for the assembly of the counterweights. These are bolted on the rear end; riveted on the front end, using a special Hanna riveter for this purpose.

Consider now a sketchy review of the practice involved in the production of the propeller shaft. The

(*Turn to page* 80 *please*)

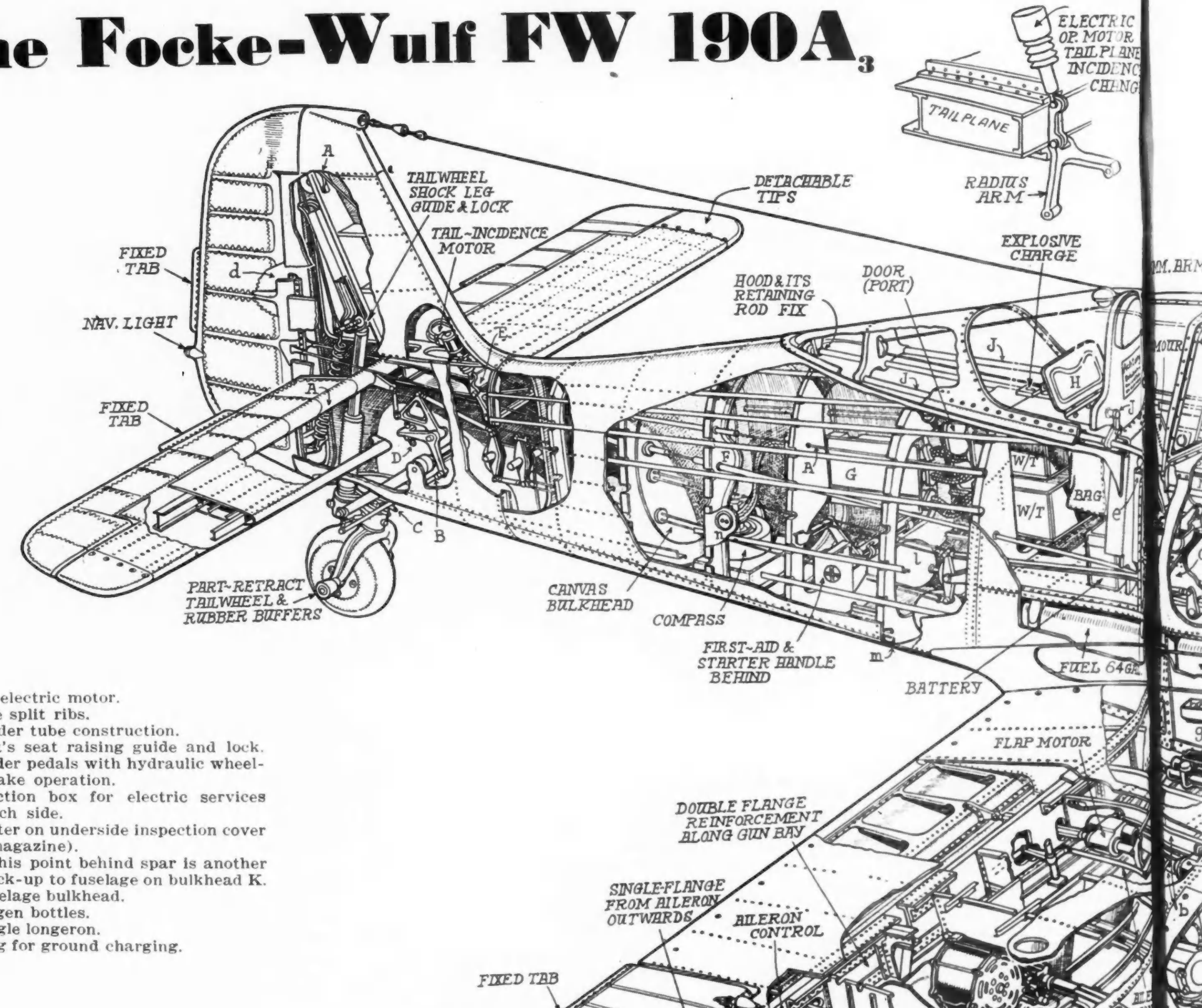


(Above) Large and small ends of link rods are honed in Barnes Drill Co., honing machines fitted with special Micromatic hydraulic fixtures and honing tools.



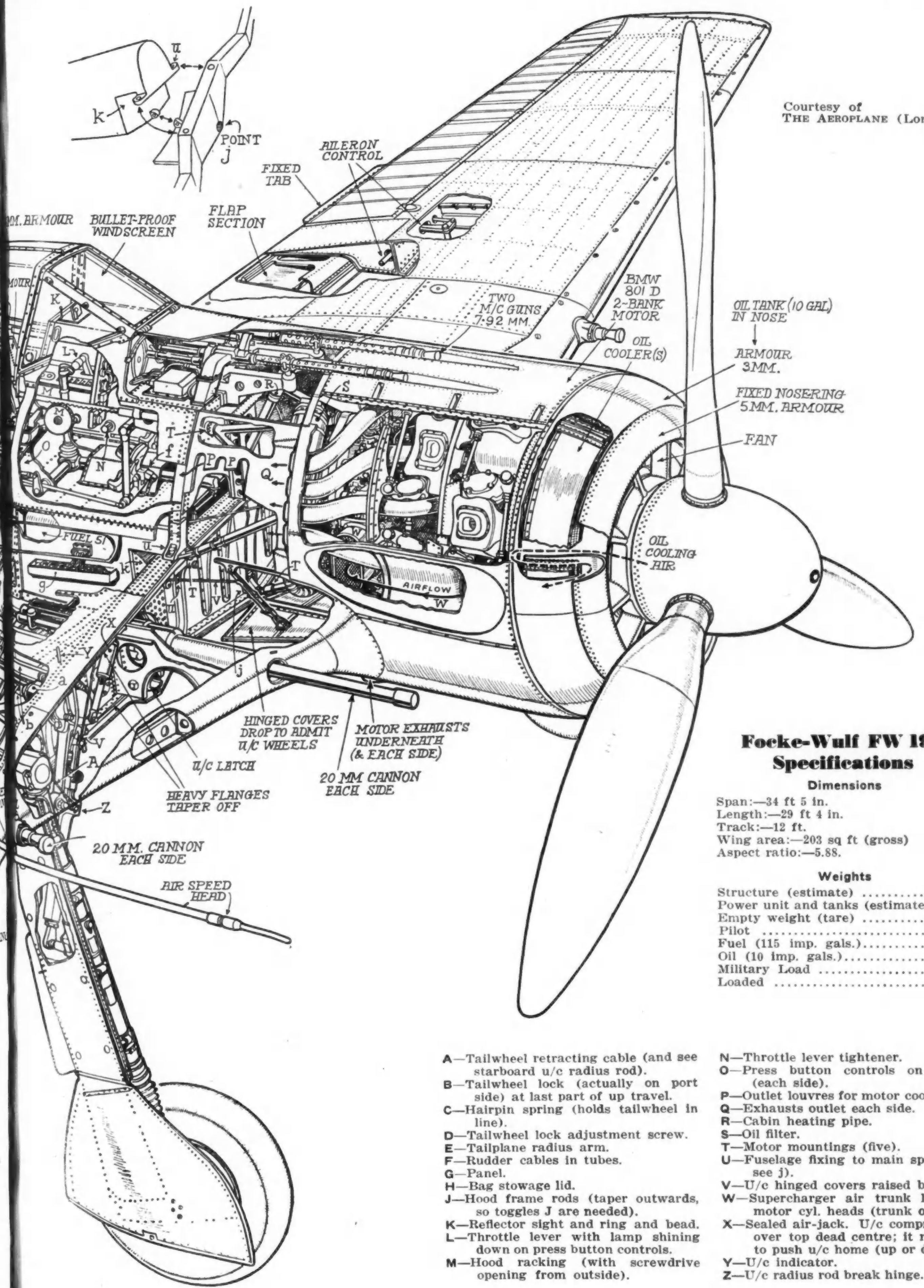
(Right) Here is one of the Andrew C. Campbell "Cutomatic" cut-off saws used in the Buick plant for the rapid preparation of test pieces, removed from the end of crankshafts and propeller shafts.

The Focke-Wulf FW 190A$_3$



a—U/c electric motor.
b—Note split ribs.
d—Rudder tube construction.
e—Pilot's seat raising guide and lock.
f—Rudder pedals with hydraulic wheel-brake operation.
g—Junction box for electric services each side.
h—Blister on underside inspection cover (magazine).
j—At this point behind spar is another pick-up to fuselage on bulkhead K.
k—Fuselage bulkhead.
l—Oxygen bottles.
m—Angle longeron.
n—Plug for ground charging.

A general description of the Focke-Wulf FW 190 appeared in the Sept. 15 issue of AUTOMOTIVE *and* AVIATION INDUSTRIES.



Courtesy of
THE AEROPLANE (London)

Focke-Wulf FW 190 Specifications

Dimensions

Span:—34 ft 5 in.
Length:—29 ft 4 in.
Track:—12 ft.
Wing area:—203 sq ft (gross)
Aspect ratio:—5.88.

Weights	lb.
Structure (estimate)	2,750
Power unit and tanks (estimate)	3,490
Empty weight (tare)	6,240
Pilot	200
Fuel (115 imp. gals.)	830
Oil (10 imp. gals.)	90
Military Load	1,220
Loaded	8,580

A—Tailwheel retracting cable (and see starboard u/c radius rod).
B—Tailwheel lock (actually on port side) at last part of up travel.
C—Hairpin spring (holds tailwheel in line).
D—Tailwheel lock adjustment screw.
E—Tailplane radius arm.
F—Rudder cables in tubes.
G—Panel.
H—Bag stowage lid.
J—Hood frame rods (taper outwards, so toggles J are needed).
K—Reflector sight and ring and bead.
L—Throttle lever with lamp shining down on press button controls.
M—Hood racking (with screwdrive opening from outside).
N—Throttle lever tightener.
O—Press button controls on panels (each side).
P—Outlet louvres for motor cooling air.
Q—Exhausts outlet each side.
R—Cabin heating pipe.
S—Oil filter.
T—Motor mountings (five).
U—Fuselage fixing to main spar (and see j).
V—U/c hinged covers raised by u/c.
W—Supercharger air trunk led over motor cyl. heads (trunk omitted).
X—Sealed air-jack. U/c compresses it over top dead centre; it rebounds to push u/c home (up or down).
Y—U/c indicator.
Z—U/c radius rod break hinge.

Part One

Two-Stroke Diesel With

AN INVESTIGATION of Diesel engine construction shows, just as the direction of domestic and foreign Diesel construction, that, with the exception of known steps, no fundamental change in the Diesel working method is to be expected at present. The engine is developing more on constructive-mechanical than on thermodynamic lines.

The attempt to raise the speed of traffic and to supply machines of the greatest power with the smallest weight and space, in recent years have pushed the two-stroke engine into the first place as particularly capable and suitable to the purpose on account of its working method. Constructively, to be sure, the two-stroke engine, partly in consequence of its later entry into development and also on account of its smaller use in traffic up to this time, lags behind the four-stroke engine.

The two-stroke engine can assume the leading position in traffic only when it satisfies a series of special requirements, of which the most important are:

1. Rapid starting of the engine;
2. Complete combustion and exhaust freedom from smoke, even with considerable speed change;
3. Economy at all operating conditions;
4. The possibility of heavy brief over-load (e. g. at the start and ascent of a heavily loaded Diesel locomotive, at the take-off of an airplane, etc.).

In the train of the development of a high-speed two-stroke engine there has been given as the principal obstacle up to this time the lack of a suitable scavenging aggregate. In order to estimate correctly what path will now be taken by technics in the solution of this important problem, one must consider that, of all the supercharger constructions which are available, the centrifugal supercharger has found the widest spread in practical engine construction. That is primarily explained by its reliability, thanks to which it has entirely displaced all other supercharger constructions in aviation.

The centrifugal supercharger is, on account of its high speed, the lightest and most compact supercharger construction. It makes possible an extremely uniform air supply and the smallest reservoir size. The pressure necessary for scavenging, 1.3—1.35 atmospheres, is reached in one supercharger stage. The most efficient drive for the centrifugal supercharger is furnished by the directly coupled exhaust-gas turbine. Experience in tests on four-stroke engines with exhaust-gas turbo-supercharger has shown sufficient operating reliability and a considerable increase in specific power, whereby the competitive capacity of the four-stroke Diesel, as compared to the two-stroke, was assured.

The successful application of the turbo-supercharger would give important advantages to the two-stroke engine as compared to the charged four-stroke engine, and as compared to two-stroke engines with other scavenging blowers. The most important of these advantages are: simple and compact design of the supercharger which is mounted directly on the engine; in comparison to mechanical blower drive: absence of gears, couplings and the like; 15—20 per cent gain in power at the engine shaft. Besides, the engine in this case acquires several further advantages, e.g., simple reversibility of the apparatus, and also the possibility of building a very fast and compact supercharger (by utilizing the highest exhaust pressure drop).

The principal obstacles in providing a two-stroke engine with a turbo-supercharger of Buchi construction have turned out to be:

1. The low temperature of the exhaust gases diluted with scavenging air, which prevents the turbine from generating the necessary power.
2. Throttling of the exhaust, which makes scavenging difficult, and causes difficulties in the working of the engine.
3. The difficulty in starting the supercharger at the proper time, at the start of the two-stroke engine.

However, these difficulties would be overcome if one maintained a definite scheme for the exhaust control (Fig.1).

This exhaust operation fundamentally consists in this, that the gases, during the exhaust period up to the beginning of scavenging, are led through the exhaust ports and the exhaust collector into the turbine. The residual gases, however, and the excess scavenging air escape during the scavenging period through other ports and a collector into the open. This method of operation furnishes the possibility of separating the amount of energetic gas which is necessary for the working of the supercharger. At the same time it is freed from counterpressure during the scavenging. That is very important for the normal running off of scavenging, and for avoiding the losses which are con-

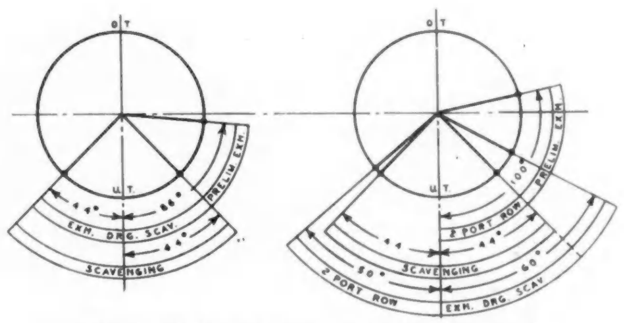


Fig. 1—Exhaust diagrams with normal and controlled exhaust.
I—Variant normal exhaust. II—Variant controlled exhaust.

By J. W. Swisstuneff
and A. A. Kuritz*

Exhaust Turbo-supercharger

Basic Design of This Engine Incorporates Exhaust Slide-Valves and Special Mechanism for Their Operation to Permit Regulation of Exhaust Opening and Degree of Compression for Various Operating Conditions. Exhaust Gases Issuing at Highest Pressure Separated to Drive Turbine.

nected with high exhaust pressure.

Complete separation of the exhaust process from the scavenging and charging processes makes it possible to hold the gas pressure p_r at the entrance to the turbine higher than the scavenging air pressure p_s. That is contradictory to the prevalent opinion that, conversely, with the two-stroke engine the scavenging air pressure p_s must be greater than the exhaust pressure p_r at the turbine entrance.

The supercharger is to be started at about 50 per cent of the full-load speed, at which about 20—25 per cent of the supercharger power required at engine full-load is used. This may be attained in one of the following ways:

1. Mechanical differential drive, which disconnects when a definite supercharger speed is reached.
2. By means of a direct current motor which is designed for 4000-5000 r.p.m. and which is mounted on the turbo-supercharger shaft on the supercharger side. Except in marine installations, an apparatus of that sort can be entirely automatic, so that when the exhaust gas turbine is working the electric motor serves as a current generator for charging the battery.
3. By starting the turbine by means of a compressed-air impulse.

If the use of the turbo-supercharger for scavenging and charging two-stroke engines has found no wide application up to this time, then the cause of this lies, not in the method itself, but, as is well known, in the lack of a complete scavenging and operating method.

At this point we will not discuss the Sulzer cross-flow scavenging and the MAN reverse scavenging systems with their low speeds and low powers (p_e is not over 4.5 kg/cm²), which makes them entirely unsuitable for high speed engines. Nor will we deal with the simple direct-flow scavenging, which was first proposed by the Russian engineer Malejew and realized by the Junkers firm and Burmeister and Wain—the most complete scavenging at present. Even this has an important defect, which clings to all the well-known scavenging systems: that is the fixed operating diagram. Since the time interval $A = c/n \cdot \int f(\phi, \lambda)\, d\phi$ is inversely proportional to the speed, the two-stroke engine with fixed operating diagram is fully evaluated within definite speed limits only if time interval, scavenging method and oscillations in the intake and exhaust are brought into agreement with each other in the best way.

The dependence of the time interval on the engine speed shows that, as the speed increases, the time interval, and therewith the power, fall; the amount of heat, however, increases. With reduction of the speed, the time interval increases, for which reason with the light-oil engine a considerable part of the cylinder charge, and with the heavy-oil engine a part of the scavenging air, escapes through the exhaust ports.

For reducing the inevitable losses resulting from outflow of the mixture or air through the exhaust ports at low speeds, one must continually change the position of the operating diagram as the speed changes ("Quality Regulation"). A variable operating diagram of that sort makes possible the smallest possible dimensions of the scavenging air compressor (reduction of the scavenging coefficient ψ). It also makes possible a regulation of the amount of exhaust gas which goes to the turbine and assures the economy of the traffic engine when operating at different speeds.

The question now arises—is it possible to furnish a simple, reliable and compact construction of an economical two-stroke engine, which, provided as a heavy or light oil engine with variable operating diagram, works in combination with a turbo-supercharger? In the following is described the working method of a two-stroke engine which shows important fundamental constructive improvements:

(a) Exhaust operation which can be changed to correspond to the port timing (change of phase and magnitude of the time interval).

* This article, published originally in the Russian periodical *Dieselestrojenije* (Diesel Construction), was translated by Dr. R. A. Castleman from *Motortechnische Zeitschrift*, Augsburg, Germany.

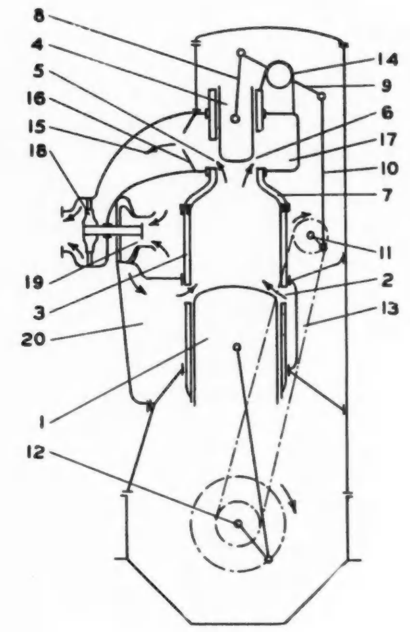


Fig. 2—Sketch of a direct flow scavenged two-stroke engine with exhaust piston slide-valve.

(b) Distributed exhaust for utilizing the exhaust gases in the turbine.

(c) Compression ratio which can be changed to correspond to the port timing; the possibility of increasing the scavenging pressure p_s, without at the same time changing the final combustion pressure p_z, and therewith the possibility of having the engine start with gasoline and later work with crude oil.

Description of the Method

The working method of a two-stroke engine with direct flow scavenging, proposed by the authors, is externally similar to the method of the Burmeister and Wain firm (exhaust piston slide-valve). However, it shows important differences in the kinematics and construction of the slide valve drive. By this the change in the magnitude of the exhaust time intervals and in the engine compression degree is made possible. (Fig. 2) The main piston 1 opens and closes the scavenging-air ports 2, which are arranged around the whole circumference of the cylinder 3. The exhaust piston 4 opens and closes the lower row 5 and the upper row 6 of exhaust ports, which are arranged in the head 7. (With mechanical blower drive the exhaust ports in the head are arranged in one row and at the same level.)

The piston 4 has approximately 20 per cent of the area and 40 per cent of the stroke of the main piston 1, and develops a power of 6 to 7 per cent of the power of the principal cylinder (according to data given by the Burmeister and Wain firm). The exhaust piston 4 drives, with the help of the drive-rod 8, of the rocker-arm 9 and of the rod 10, the operating shaft 11. This is synchronized with the main shaft 12 by means of a chain 13 or a gear train. Constructively the operating shaft can be designed with cranks or eccentrics set on, to correspond to the magnitude of the slide-valve lift. The operating shaft 11, loaded by alternating forces in agreement with the exhaust piston, can relieve the chain or gear transmission 13.

The lever 9 sits on the eccentric lever shaft 14, by the rotation of which, with the help of a servo-motor or by hand, one can raise or lower the exhaust piston, whereby the time intervals and the compression ratio of the engine are changed (Fig. 3). In the exhaust pipe 15, at the port 5, automatic leaf-valves 16 of heat-proof steel are provided, for limiting the preliminary exhaust from the residual and scavenging exhaust which leaks through the openings 6 through a receiver 17 into the opening.

These flaps close the lower exhaust row 5 after the preliminary exhaust. They require neither accurate fitting nor careful packing. Also a distortion of the valve plates has apparently no practical importance, because a worth-mentioning back-flow of the gases into the cylinder is excluded. Conical inserts in the exhaust pipe would serve the same purpose.

The gases of the preliminary exhaust are led into the gas turbine 18 through the pipe 15; on the turbine shaft is mounted the scavenging-air compressor 19, which supplies air to the scavenging-air reservoir 20.

The scavenging ports 2 are uncovered by the exhaust piston after the ports 6 have begun to open. The scavenging ports are closed after the exhaust ports 5, whereby a charging effect is obtained. Otherwise the working method is similar to that with an engine with opposed pistons.

Bases of the Method

There is no doubt that the direct-flow scavenging makes possible a comparatively high effective working pressure (p_e = 6—8 kg/cm²), while other systems give a p_e of only 4.25 to 5.3 kg/cm². The proposed method of application of an exhaust-gas turbo-supercharger shoves the working pressure still higher. The direct-

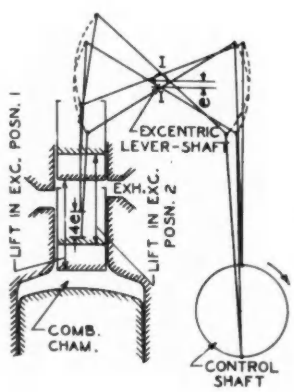


Fig. 3 — Kinematic sketch of an exhaust slide-valve mechanism.

flow scavenged Junkers engine works at a speed of 2400 r.p.m. The firm expresses the conviction that a powerful, direct-flow scavenged engine can be made to operate at 3000-4000 r.p.m.

In practice one can expect that the direct flow scavenging, in combination with a piston slide-valve driven in the proposed manner, does not limit the speed of the engine so much as other scavenging systems, and as the exhaust valve in the case of direct-flow scavenging. From this viewpoint the proposed method proves particularly suitable for light high-speed engines for automobiles and airplanes. The advantages

of a piston-type exhaust valve over poppet valves are the following:

1. The combustion chamber attains a favorable shape, which improves the combustion process and the charging.

2. The crank mechanism operates noiselessly.

3. The influence of the thermal expansion of the cylinder on the operation is lacking.

4. In case of necessity, the piston slide-valve is easier to cool than valves which, in consequence of the flow of exhaust gases past them, work at high temperatures.

5. The comparatively low mean velocity and the small side thrust of the piston slide-valve assure continuous, reliable operation.

6. The principal defect of the exhaust valve, which limits its use to engines of medium speed, lies in the dynamics of the valve mechanism.

That may be seen from a comparison of the working conditions for the valve mechanism of a two-stroke and a four-stroke engine. For example, with parabolic cam shape, the accelerations with the two-stroke engine are expressed by the equation

$$\gamma = \frac{2\omega^2 h_m k}{\Theta_0^2} = \frac{2\pi^2 k h_m n^2}{(30\Theta_0)^2}$$

In this:

ω is the angular velocity of the operating shaft,
h_m is the maximum valve lift,
k is the coefficient which characterizes the contact point of the parabola,
Θ_o is the angle between the beginning and highest point of the cam-lift curve.

From this equation it may be seen that the acceleration is proportional to the valve-lift and to the square of the speed, and inversely proportional to the square of the angle between beginning and highest point of the valve-lift curve.

The coefficient k and the greatest valve-lift h_m are the same for the two-stroke and for the four-stroke engines. The speed of the operating shaft is, with the two-stroke engine, equal to the speed of the crankshaft, while with the four-stroke engine the operating shaft makes only half as many revolutions. The total crank angle during the lifts of intake and exhaust valves, is, with the four-stroke engine, approximately 220-260 deg., but the corresponding cam-angle of the operating shaft is only half as great: ϕ_1 = 110-130 deg.

With valve-operated two-stroke engines the valve uncovering can begin 80-85 deg. before lower dead center. In this the lost pressure is not important, because the sectional area of the valve is small in the first moment after the uncovering. The gases are in the expansion guided against the piston which is still moving downwards, and have a certain inertia which, in the first moment, slows the outflow through the valve. The end of exhaust is about 45 deg. after lower dead center. Therefore, the total valve opening angle with the two-stroke is ϕ_2 about 125 deg.; the relation applies: $\phi_2/\phi_1 = 1$.

From the investigations which have been performed on the influence of all the factors on the magnitude of the valve acceleration it has turned out that, at the same crankshaft speed of four- and two-stroke engines, the valve acceleration is four times as great with the latter. To be sure, the comparison of these accelerations is not so important with machines of medium speed. For this reason, in the USSR and abroad the scavenging method with the exhaust valves is used and tested. In the case of the exhaust which is subdivided into pre-exhaust and following-exhaust (I. valve group: exhaust gases to go to the turbine; II. valve group: gases go into the open), the valve lift angle is decreased. The first valve group can be uncovered 85-90 deg. before lower dead center, and close at dead center. The second valve group opens about 45 deg. before lower dead center and closes 45 deg. after lower dead center. The ratio (ϕ_2/ϕ_1) is about 0.6-0.7 (compare the angle of the operating diagram in Fig. 1).

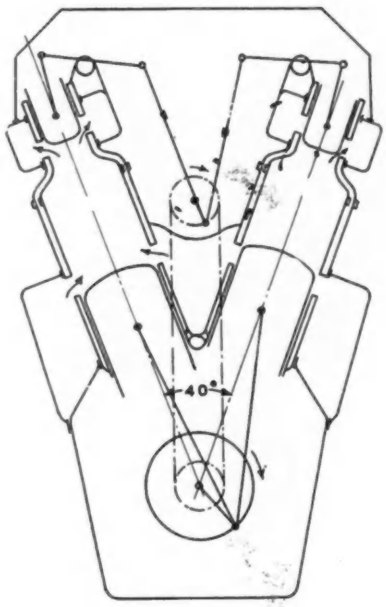


Fig. 4 — Two-stroke engine in V-form with exhaust piston slide-valve.

The angle between beginning of opening and full valve lift Θ_o = 47.5 deg. in this case reaches a magnitude of less than one radian. Because Θ_o^2 stands in the denominator in the expression for the acceleration, and because Θ_o is less than one radian, in this case the acceleration increases very strongly. At the same crankshaft speeds of four-stroke and of two-stroke engines, the valve acceleration in this case increases in the ratio $4k^2$, in which k = 1.65-1.45; and, depending on the absolute size of the engine, it assumes values up to 800-1000 m/s^2, which brings with it difficulties in the constructive realization of the valve mechanism.

In the proposed method, the presence of a very simple crank mechanism connected with the exhaust piston reflects the idea that the direct-flow scavenging makes the two-stroke engine practical. Such measures as two rows of ports in the liner and block, a great number of automatically operated suction openings with the Sulzer engine and the use of an exhaust angle slide-valve in the MAN are by no means more simple than the proposed exhaust piston drive, and besides do not have sufficient effect.

The proposed method is particularly suitable for V-engines. Such a V-engine is shown in diagram in Fig. 4, which needs no explanation.

Part Two will appear in the December 1, 1942, issue of AUTOMOTIVE *and* AVIATION INDUSTRIES

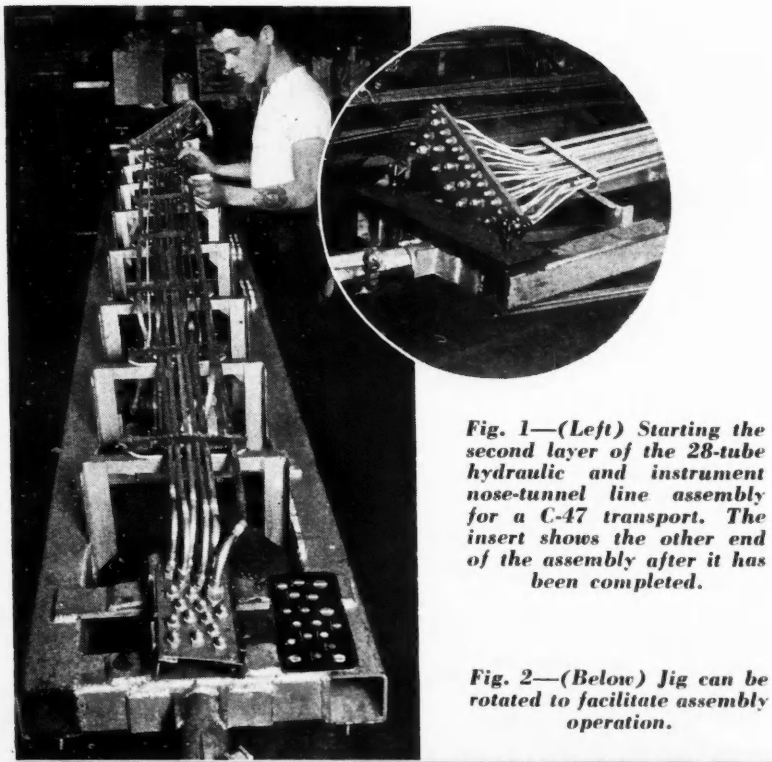


Fig. 1—(*Left*) *Starting the second layer of the 28-tube hydraulic and instrument nose-tunnel line assembly for a C-47 transport. The insert shows the other end of the assembly after it has been completed.*

Fig. 2—(Below) Jig can be rotated to facilitate assembly operation.

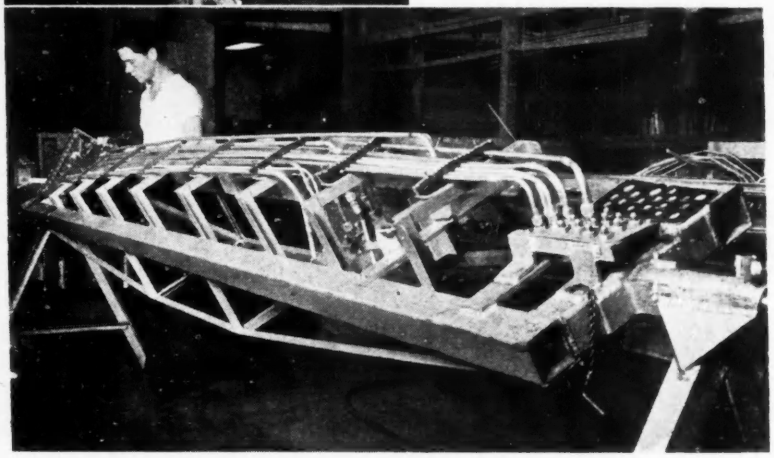


Fig. 3—(Below) Inner anchor point of hydraulic and instrument nose-tunnel line assembly.

JIG

Douglas finds this method to be a big time saver

HUNDREDS of man-hours are saved daily and installation damage is kept down to new lows by jig assembly of hydraulic, fuel, instrument and other tube lines at the Douglas Aircraft Company's Long Beach, California, plant. This new method also is increasing employe efficiency to new highs by permitting assembly and installation operations in less tiring working positions. Regardless of the size and final shape of the line assemblies, which vary from small six-line, five-footers with five bends per line to big 47-line, six-footers of ¼ in. to 1 in. diameters and two to four bends per line, they go together faster, easier and more accurately in the jigs than was possible by the previous, individually installed, single-line-at-a-time method.

Time savings are uniformly big with the new assembly setups, one of which is shown in Fig. 1 to 4, inclusive. By former methods this 28-line, 14-foot assembly required 24 man-hours to assemble and install on the ship. By the present jig method, assembly and installation require only four man-hours.

Jig tripods are 1½ by 1½ by ⅛ in. angle steel and are not anchored to the floor. Frames are square steel tubing mounted in squeeze-locking bearings that permit 360 degrees side-wise rotation for easier and faster work on otherwise difficult-to-reach couplings and clamp bolts.

All lines come to the assembly department cut to length and with couplings attached. Those above ¼ in. in size are pre-formed. The ¼ in. are bent as attached in the jig. Couplings are protected against handling damage by metal seal caps requiring only 1 to 4 turns to apply or remove. Assembly by the jig method makes all of them used on the Douglas C-47 transport, even the largest, one-man operations.

ASSEMBLY

of Tube Lines for Aircraft

Fig. 4—(Above) Installing the jig-assembled line assembly in nose section tunnel.

Fig. 5—(Below) Jig assembling cowl flap lines. Guide rods are provided for bending small tubes.

Fig. 6—(Below) An assembler and a learner are assembling the 47 lines, all with breaks, to be installed in the leading edge of a C-47 inner wing section. Normally, one assembler does this 16-foot-long assembly alone in 2½ hours.

Connecting plates, other than those normally a part of the assembly itself, are equipped with nipples duplicating those in junction boxes on the ship and are permanent parts of the jigs, but are adjustable and can be removed for replacements if changes make that necessary. When assembled and inspected, by disconnecting the coupling from the nipples on the jig plates, an assembly can be lifted from the jig by one man and racked for transfer to the installation department.

Shown in Fig. 1 in the foreground are assembled guide cards bearing, in exact size and proper location, an end-view diagram of each line to be installed, labeled with its stock number and colored, striped identification marking. Through their use error is eliminated and speedy assembly made possible, even by more or less inexperienced workmen.

Smooth, round guide posts on top of the jig brackets anchor the Adel clamps in correct position and without the loss of time fastening them with bolts would entail. When the assembly is complete and clamps have been tightened, tubes are pried to proper distances apart and, in some instances, are laced with Koroseal thongs to prevent vibration, before the assembly is removed from the jig. Details of operations illustrated in the series of photographs are described as follows:

Fig. 1, an endwise view from above, shows the placing of the first line, second layer of a 28-tube hydraulic and instrument nose-tunnel line assembly, in the Adel clamps after its other end has been attached to the regular assembly junction plate at the far end of the jig. When also connected to the permanent junction plate, shown in Fig. 3, that line is complete and the operator proceeds to the next one. Lines of the lower layer are already in place in the clamps and the

(*Turn to page* 74 *please*)

Semi-enclosed Frazer-Nash turret of 1936 on a Hawker-Demon, the first fighter with a power-operated turret.

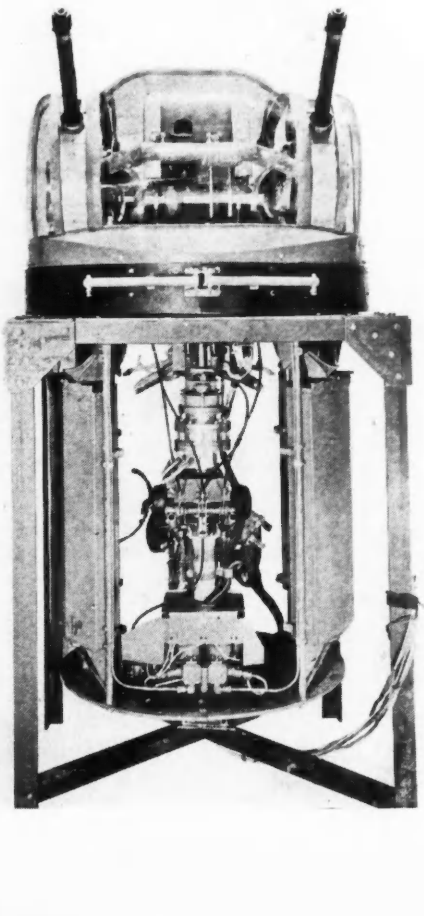
By M. W. Bourdon

Special Correspondent of AUTOMOTIVE *and* AVIATION INDUSTRIES in Great Britain

IT WAS well stated recently by the writer of a series of articles in *The Aeroplane* (London), entitled "The Weapons of Air Warfare," that if the advance of fighter armament has been astonishing that of the bomber has been still more remarkable in some respects. The same writer went on to say:

"The power-operated gun turret, displacing the open Scarff gun ring, has had far-reaching effect upon bomber design, and it is not too much to say that the 'big bomber' policy, which forms such a vital part of Britain's war effort, was made possible only by the evolution of the multi-gun turret during the past eight years."

So far as it is on record, history does not relate who actally pioneered the power-operated and enclosed gun turret, or when such a thing was first fitted to an aircraft. But it would appear that the first Service aircraft to be so equipped was the Overstrand of 1934, a medium bomber made by the Boulton Paul Aircraft Co., who also were the designers and manufacturers of the turret. This early Boulton Paul turret, forming the nose of the machine, was hydraulically operated and carried a single Lewis gun. Since then its manufacturers have specialized in the production of power-operated turrets for various airplane manufacturers, as well as producing military aircraft. Of the latter, the latest about which information has been released is the Defiant two-seat night-fighter, which was illustrated and described in AUTOMOTIVE and AVIATION INDUSTRIES of May 15 and which has the distinction of being the first of the fighter type to have a power-operated four-gun turret.

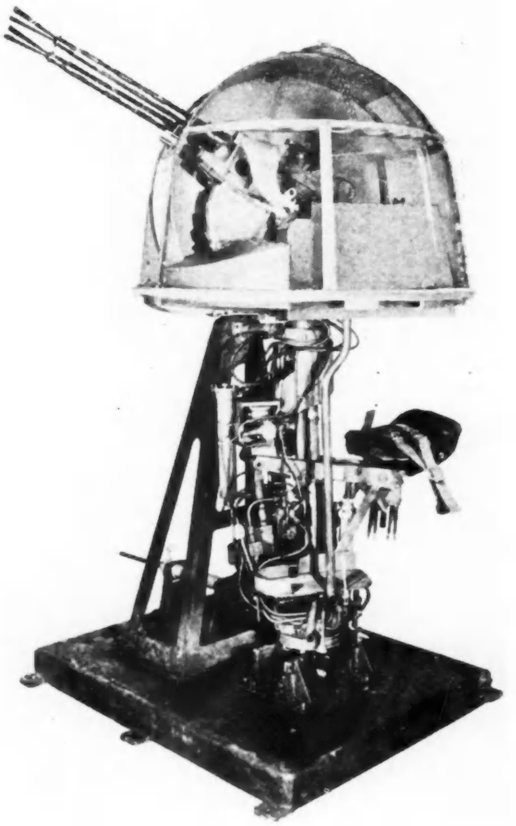


Current type of Bristol twin-gun turret fitted to English and Australian-built torpedo-bombers and other warplanes.

The 1934 Boulton Paul turret was the only one of this make to have all-hydraulic operation. The latter was superseded by an electro-hydraulic system, which, in its latest form is used on the Defiant, the Halifax II four-engined heavy bomber, the Blackburn Roc (the first aircraft of the Fleet Air Arm to have a power-operated four-gun turret, in rear of the pilot's cockpit) and the Lockheed Hudsons and the Consolidated Liberators as used by the Royal Air Force. The Halifax turrets have Browning .303 in. guns, two in the front turret, four in the mid-upper position and four in the tail. Lockheed Hudsons have a two-gun upper turret and Liberators a four-gun upper and four-gun tail.

A make of turret that has a record of twelve years development behind the examples now in use is the Bristol, produced by the Bristol Aeroplane Co., whose renown among British manufacturers of military aircraft goes back to 1914, when the Bristol Bullet, a single-seat biplane with a fixed Vickers machine gun, was produced. In 1930 the Bristol Co. designed and de-

Gun Turret Development in England



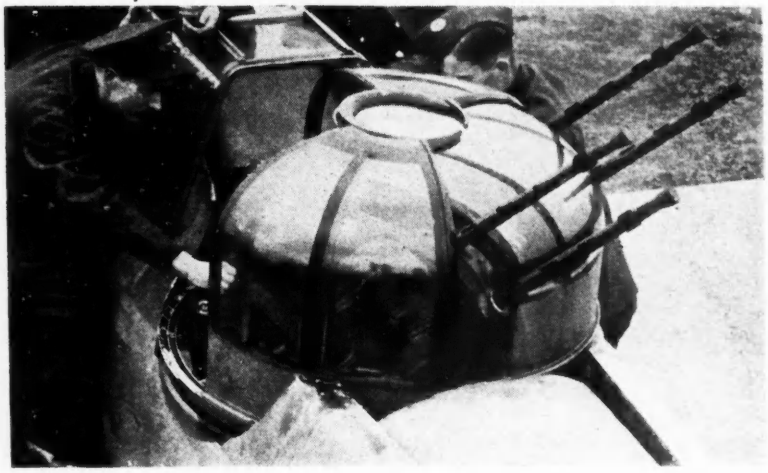
In 1936 British Blenheim bombers were equipped with Bristol mid-upper turret of this design. It is hydraulically operated both for rotation and retraction. The machine guns are Brownings.

veloped a mechanically operated turret which was fitted early in 1931 to the company's Type 120 aircraft, though it was not adopted by the Royal Air Force. It seems to have consisted basically of a Scarff gun mounting with a transparent cover that caused it to be termed the "Bird-cage." About 1932 Bristol started on the development of an hydraulic system of turret operation, hand in hand with the development of the Bristol hydraulic control system for other aircraft services, such as operation of the flaps, under-carriage, etc. But it was not until 1935 that the first Bristol hydraulically-operated turret was fitted to an aircraft. It was then applied to the nose of a Bristol Bombay bomber-troop carrier, which later had a power-operated Bristol tail turret added to its armament.

In 1936 the first Bristol hydraulically-operated turret to be located amidships was fitted to the Bristol Blenheim bomber, which also had the distinction of being the first modern type of all-metal, stressed skin, cantilever monoplane to go into production for the Royal Air Force. This application of a mid-upper turret with hydraulic operation to a high performance monoplane was an outstanding development, for it has proved to be of high value by enabling the gunner to aim and fire steadily and accurately broadside, on either beam, even when flying at high speeds.

Here it may be emphasized that the success of the Bristol hydraulically-operated turrets and hydraulic control of aircraft in general has rested undoubtedly upon the development of the Bristol hydraulic pump, now produced in large numbers and extensively used for many aircraft services. It is a three-stage pump giving pressures of 1500 psi or more (instead of the normal pres-

Boulton Paul power-operated gun turret on the nose of an Overstrand bomber in 1934. It is said to be the first to be installed on a Service airplane.



Boulton Paul four gun electro-hydraulically operated turret on the British Defiant night fighter.

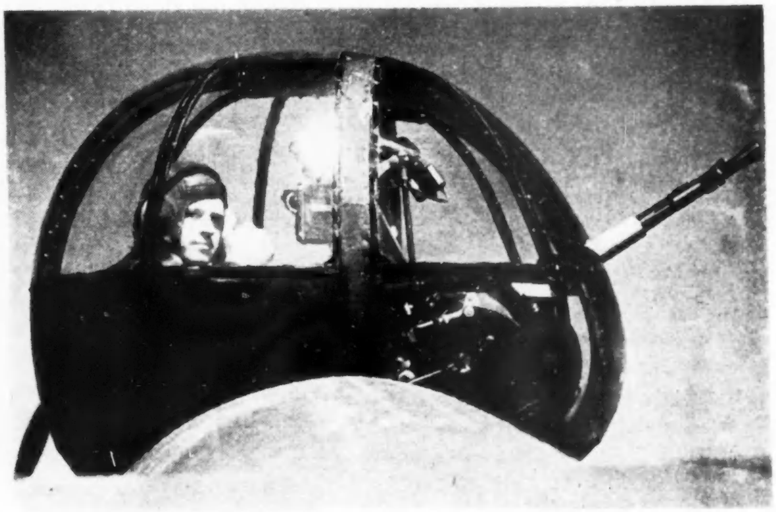
sure of about 300 psi), with a flow of six Imperial gallons per min. at normal engine speed. It now forms part of the back cover equipment of all types of Service aircraft, with both liquid-cooled and air-cooled radial engines, British and American, and has been described by one designer as "the salvation of aircraft designers," providing as it does a smooth flow at any of the high pressures required.

The Bristol turret as fitted to the Blenheim bomber in 1936 was notable in several respects. In the first place it was exceptionally small, having a gun ring of only 30 in. in diameter, and was housed in a low-drag retractable cupola operated mechanically, which features were attained largely by the use of a moving seat for the gunner synchronized with gun movement. It also had a "secondary motion" of the gun column. Originally it was fitted with a single Lewis gun and later with a Vickers "gas operated" gun. Later still it was developed for twin Browning guns.

Bristol turrets now in use are notable for their relative simplicity, low weight and small dimensions. They are claimed to be easier to manufacture than their contemporaries, to weigh only about half as much with the same armament and to be smaller with the same effectiveness. number of guns, supply of ammunition and field of fire. If a gun should jam it can be cleared by the gunner while the aircraft is in flight. Bristol engineers pioneered a restrictor gear and fire cut-out, enabling the gunner to rotate his turret throughout its circuit at full speed without fear of damage and to avoid shooting off or fouling any part of the fuselage, tail unit or other part. They also developed a special gun mounting incorporating a simple "harmonization gear," which enables four guns, when provided, to be lined up quickly and independently on the target, while by means of a quick-release device each gun can be removed and replaced easily and quickly without handling anything but the gun, which is automatically locked in position when installed.

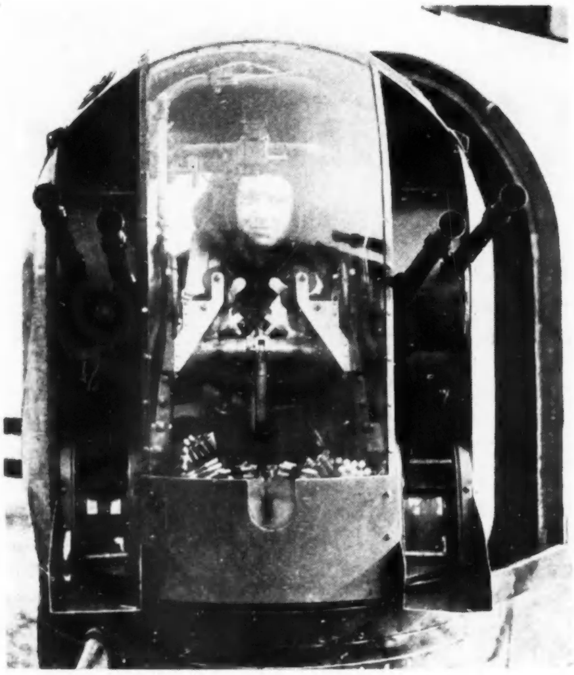
Bristol turrets are now both rotated and retracted entirely by hydraulic means. They are fitted to all Bristol aircraft having turrets, including the Australian-built Beaufort torpedo-bombers and the Canadian-built Bolingbrokes.

Although Boulton Paul may be said to have pioneered the power-operated gun turret by applying it to the nose of their Overstrand bomber in 1934, the distinction of devising the first power-operated upper turret for a fighter appears to be attached to Captain Frazer-Nash. During the war of 1914-18, Frazer-Nash was associated with the production of the Constantinesco synchronizing gear, which enabled a machine gun to be fired between the rotating blades of a tractor propeller, and in 1936 a power-operated turret of his design was flight-tested on a Hawker-Demon two-seat fighter, a biplane of which a number with this turret were subsequently acquired by the Royal Air Force. But this early Frazer-Nash turret, mounting a single Lewis gun and having hydraulic operation, did not completely fulfil the modern conception of a gun turret, for it was not fully enclosed, lacking a roof. Moreover, its field of fire was confined to either side and to the rear; in front of it was the upper plane, not to mention the pilot's head and shoulders and the propeller.



Boulton Paul two-gun dorsal turret with electro-hydraulic system is used on Halifax II, Lockheed Hudson and Consolidated Liberator planes of the RAF.

About 1936 various manufacturers of aircraft besides Bristol commenced to develop gun turrets for machines of their own make. These included the nose and tail turrets of the early Whitley bombers, in each of which a single Vickers machine gun was mounted



Rear gun turret on the Stirling bomber. It is a Nash and Thompson make, similar to the one on the Whitley bomber. For operation armor plate is placed in front of the gunner to protect him.

and which were of Armstrong Whitworth design. These original Whitleys also had two Browning guns fired from a "dust-bin" type of turret, located beneath the fuselage, a scheme that had been tried on a Handley Page aircraft as far back as 1930.

A contemporary of the early Whitley bomber which also had power-operated turrets designed and made by the aircraft manufacturer (Vickers) was the Wellington bomber in its original form. Three were provided in this case, each with two Browning machine guns.

But neither the Armstrong nor the Vickers turrets gave full satisfaction, and thereafter turret design and production tended to become a specialist's job. Of late years three makes alone have been found on British military aircraft—the Boulton Paul, Bristol, and Frazer-Nash, the latter now generally termed the Nash and Thompson though sometimes referred to as the Parnall, the name of the manufacturing company, Parnall Aircraft. Later versions of the Whitley and Wellington bombers have had turrets of Frazer-Nash design. The Whitley was given a four-gun turret behind the tail unit and was the first bomber in the world to have such a powerful armament astern, though a Frazer-Nash four-gun tail turret was installed at about the same time (1937) in a Short-Sunderland flying boat. Besides the tail turret, the latter aircraft had two hand-operated guns amidships and a single gun in the nose; it set new standards in the armament of marine aircraft and when it first appeared in action was named the "Flying Porcupine" by German pilots who came within its range and escaped destruction. Among current British machines, the Stirling four-engined bomber has the latest Nash and Thompson turrets, with all-hydraulic operation. Nash and Thompson claim to have pioneered the retractable under-turret with power operation, but about this nothing can now be said.

Before the war, as previously mentioned, Boulton Paul developed a turret with electro-hydraulic operation, and in 1939 a two-gun unit of this type was fitted to the first Coastal Command aircraft to be equipped with a power-operated turret. This was the Lockheed Hudson, the upper two-gun turret of which converted this civil transport machine into an efficient type for general reconnaisance work. All Boulton Paul turrets now in use have the electro-hydraulic system of operation.

While little can be said of the details of recent and prospective development in British turrets, owing to

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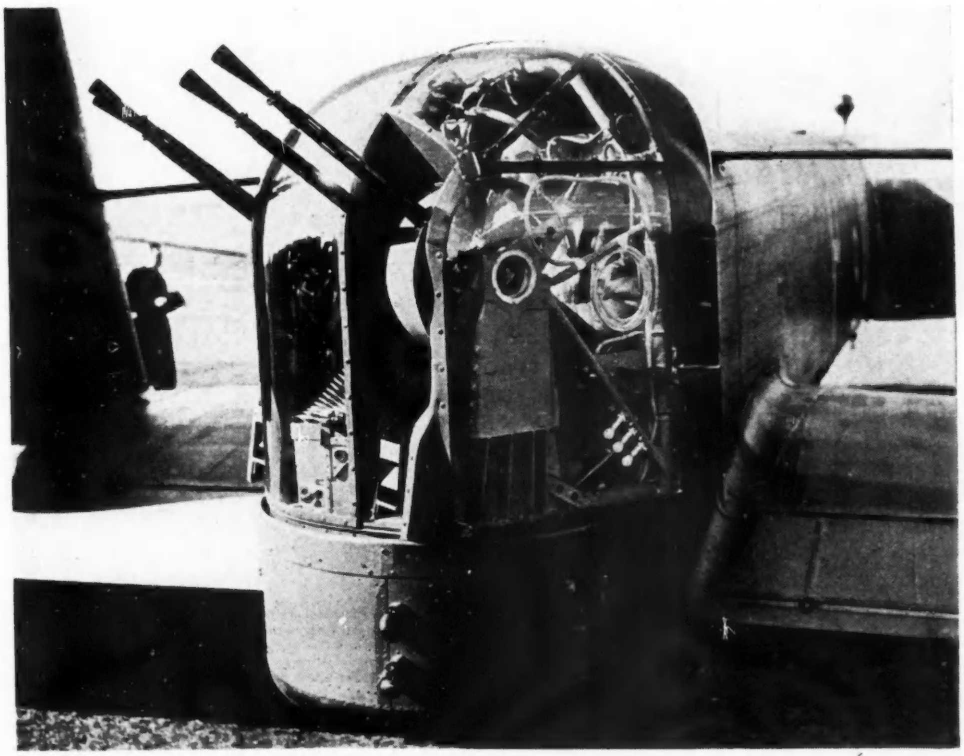


Nash and Thompson (Parnall) rear gun turret on a Whitley bomber.

Machining Aluminum

ALUMINUM and its alloys, when compared with the other commercial metals, can be machined both readily and effectively. Aluminum alloys come in both a cast and wrought condition, a fact that must be considered when preparing to machine the metal. Some of the alloys have better machining properties than others, thus enabling them to be worked fast, while producing small chips and smooth surfaces. Other alloys are less easy to machine, and produce either long and stringy or soft and gummy cuttings.

Among the alloys that can be machined most readily are casting alloys containing chiefly copper, magnesium, and zinc. The tools employed here may have smaller rake angles than those required for most of the other alloys, the chips are small, and there is little or no tendency for the tools to leave a burr or for the chips to build up on the cutting edge. On the other hand, the casting alloys, in which silicon is the predominant alloying element, machine best if the speeds and cuts are reduced and the rake angles increased. These alloys are abrasive to carbon and high-speed tools, and should be machined with cemented carbide-tipped tools.

In considering wrought alloys, it is important to remember that these, depending on various amounts of work hardening to improve their mechanical properties, are easy to machine with tools having relatively large rake angles. Other alloys also have good machining characteristics as a rule. Even the softest aluminum may be machined with excellent results when large rake angles are employed and the tools are carefully finished with a fine abrasive stone. The following table shows the approximate machinability of the cast and wrought alloys. Those listed under Type I have the best machinability, those under Type II the next, and those under Type III the poorest. (See Table 1.)

Table 1—Commercial Aluminum Alloys

Type*	Alcoa Alloy	COMPOSITION (per cent)				
		Cu	Fe or Mn	Si	Mg	Other
		Non-Heat-Treated Casting Alloys				
I	173	7.0	......	...	...	2.0 Sn
	C113	7.5	1.2 Fe	4.0	...	2.0 Zn
	645	2.5	1.5 Fe	...	...	11.0 Zn
	B113	7.5	1.2 Fe	1.5	...	......
II	112	7.5	1.2 Fe	...	...	2.0 Zn
	216	....	......	...	6.0	......
	A214	....	......	...	3.8	2.0 Zn
	109	12.0	......	...	...	......
	12	8.0	......	...	...	......
	214	....	......	...	3.8	......
	212	8.0	1.0 Fe	1.2	...	......
	B214	....	......	1.8	3.8	......
III	172	7.8	......	2.5	...	......
	A108	4.5	......	5.5	...	......
	108	4.0	......	3.0	...	......
	356	....	......	7.0	0.3	......
	43	....	......	5.0	...	......
		Heat-Treated Casting Alloys (a)				
I	220(b)	....	......	...	10.0	......
	122	10.0	1.2 Fe	...	0.2	......
II	D195	5.5	......	0.7	...	......
	142	4.0	......	...	1.5	2.0 Ni
	195	4.0	......	...	...	......
	B195	4.5	......	3.0	...	......
III	355	1.3	......	5.0	0.5	......
	A355	1.4	0.8 Mn	5.0	0.5	0.8 Ni
	356	...	......	7.0	0.3	......
(c)	A132	0.8	0.8 Fe	12.0	1.0	2.5 Ni
		Heat-Treated Wrought Alloys (a)				
I	11S	5.5	......	...	...	0.5 Pb+0.5 Bi
II	61S	0.25	......	0.6	1.0	0.25 Cr
	53S	...	......	0.7	1.3	0.25 Cr
	A51S	...	......	1.0	0.6	0.25 Cr
	17S	4.0	0.5 Mn	...	0.5	......
III	25S	4.5	0.8 Mn	0.8	...	......
	70S	1.0	0.7 Mn	...	0.4	10.0 Zn
	18S	4.0	......	...	0.5	2.0 Ni
	14S	4.4	0.8 Mn	0.8	0.4	......
	24S	4.4	0.5 Mn	...	1.5	......
(c)	32S	0.8	......	12.0	1.0	0.8 Ni
		Non-Heat-Treated Wrought Alloys				
II	56S	...	0.1 Mn	...	5.2	0.1 Cr
III	4S	...	1.2 Mn	...	1.0	......
	52S	...	......	...	2.5	0.25 Cr
	3S	...	1.2 Mn	...	...	......

* Indicates relative machinability. Type I alloys have best machining characteristics.
(a) Heat treated as usually sold, namely a solution treatment followed by aging at room or elevated temperature.
(b) Alloy 220 is not aged.
(c) Alloy cuts freely, but wear on tools may be excessive unless they are tipped with cemented carbide.

Machining Tools

It is possible to use tools designed for cutting other commercial metals when machining aluminum. However, better results can be obtained if a tool is used that takes into consideration the specific properties of the metal. For this reason it is best to grind more top and side rake on the cutting tools than is common for machining steel, keep cutting edges sharp and free of burred or wire edges, and maintain smooth, bright tool surfaces free from scratches.

By R. L. Templin

Chief Engineer of Tests
Aluminum Co. of America

Plain high-carbon steel tools usually perform effectively when machining aluminum at low speeds. For quantity production work, tools of high-speed steels and cemented carbide tips have proved superior. The latter type of tool is economical for high rate production; since, when ground to proper rake angles, they produce excellent surfaces and remain sharp for long periods of time without regrinding. The use of cemented carbide tools is restricted to operations in which the work is free from vibration and irregularities in the cut.

Tool Shapes

Regarding tool shapes, top rake generally varies from 20 to 50 degrees. Side rake, important because of the slicing action it produces in parting the cutting from the stock, usually should be from 10 to 20 degrees. In general, the larger rake angles cited are employed for finishing tools, while rake angles in the lower range are used for roughing cuts. Clearance should be about 8 or 10 degrees, and must be carried around the side of the tool which advances into the work. Since the success of the machining operation depends greatly on tool finish, it cannot be emphasized too greatly that cutting edges be keen, smooth, and free from grinding wheel scratches, burrs, or wire edges.

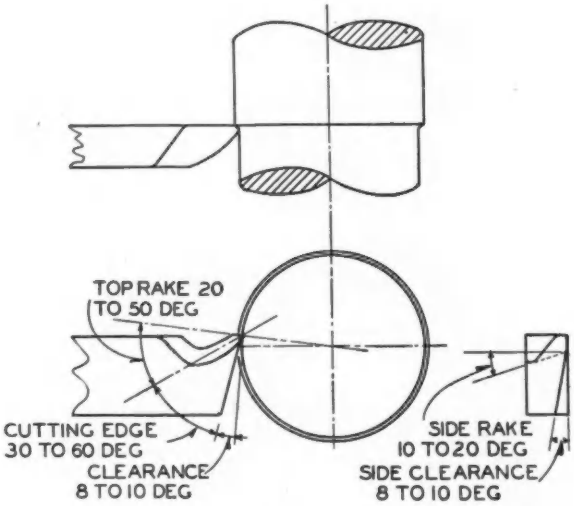


Fig. 1. Diagram showing a typical lathe tool for machining aluminum. Note that the tool is set slightly above center.

Typical of the equipment used in machining alu-

Table 2—Cuts, Speeds, and Feeds When Machining Aluminum Alloys

(See Note)	ROUGH MACHINING			FINISH MACHINING		
	Max. Cut Inches	Speed (fpm)	Feed, Inches	Cut, Inches	Speed (fpm)	Feed, Inches
LATHE TURNING						
Type I castings, not heat treated	0.25(a)	500 to 900	0.020 to 0.030	0.002 to 0.010	Maximum	0.002 to 0.010
All others	0.19(a)	400 to 800	0.007 to 0.020	0.002 to 0.010	600 to 900	0.002 to 0.010
MILLING						
Type I castings, not heat treated	0.25	400 to 600(b) 500 to 700(c) Maximum (d)	5 to 15(e)	0.010 to 0.020	500 to 700(b) 500 to 700(c) Maximum (d)	10 to 25(e)
Type I castings, heat-treated Type II castings Types I and II wrought alloys, heat-treated	0.25	400 to 600(b) 500 to 700(c) Maximum (d)	4 to 10(e)	0.010 to 0.020	500 to 700(b) 500 to 700(c) Maximum (d)	5 to 15(e)
Type III alloys	0.25	300 to 500(b)	3 to 8(e)	0.010 to 0.020	500 to 700(b)	4 to 10(e)
BORING						
Light duty (1 to 2 inch)	0.09(a)	Maximum(f)	0.010 to 0.020	0.010 to 0.020(a)	Maximum(f)	0.001 to 0.005
Medium to heavy duty	0.25(a)	600 to 1000	0.007 to 0.015	0.010 to 0.020(a)	600 to 1000	0.001 to 0.003
SHAPING						
Heavy duty (36 inch)	0.25	Maximum(g)	0.010 to 0.030	0.005 to 0.010	Maximum(g)	0.100 to 0.150
PLANING	0.38	Maximum(h)	0.025 to 0.100	0.005 to 0.015	Maximum(h)	0.050 to 0.375

Note: See Table I for explanation of Type numbers listed above in first column.
(a) Cut measured on radius.
(b) For carbon steel tools.
(c) For high-speed steel tools.
(d) For cemented carbide tools.
(e) Travel of work.
(f) Peripheral speed of tool is maximum of most machines.
(g) Travel of ram.
(h) Speed of table.

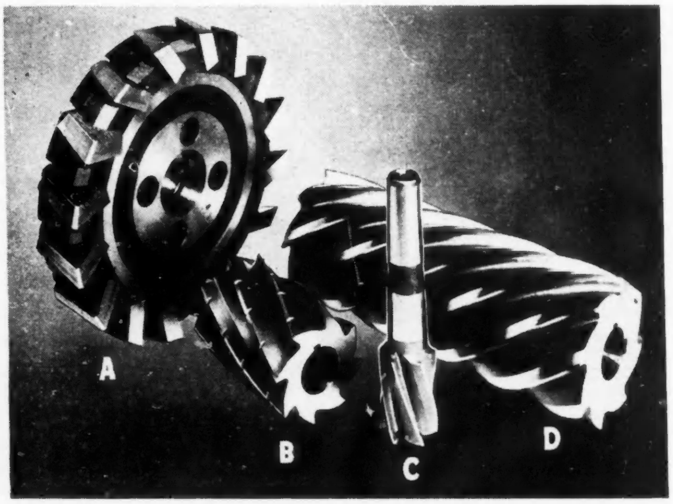


Fig. 2. Here are some milling cutters for aluminum. (A) Inserted-tooth face milling cutter; (B) Spiral nicked-tooth plain milling cutter; (C) End mill for milling aluminum; and (D) Helical milling cutter.

minum and its alloys is the lathe tool shown in Fig. 1. It will be observed that the tool may have a top rake of 20 to 50 degrees, a side rake of 10 to 20 degrees, a cutting edge of 30 to 60 degrees, and is provided with a front clearance of 8 to 10 degrees. The cutting edge of the tool should be set above the center line of the work to reduce the tendency to chatter. Although this same tool may often be used for both roughing and finishing cuts, it is important that the cutting edge be restoned before the latter operation.

The design of the lathe shown in Fig. 1 can be considered typical of all the cutting tools employed in machining aluminum and its alloys. Top rake and front clearance of parting tools may be somewhat less. In general, a top rake of 12 to 20 degrees and a front clearance angle of 3 to 4 degrees are sufficient. Facing tools usually have a side rake of from 10 to 20 degrees, while the tools employed on planers and shapers are ground with about the same cutting edges as those used for lathe work. Milling cutters, straddle mills, end mills, and similar cutters give more satisfactory results if the tools are of the coarse-tooth, spiral type and have considerable top rake on their cutting edges. A milling cutter three inches in diameter with 8 teeth, deeply cut, provides ample clearance for cuttings. The teeth should be undercut to provide a top rake angle of 10 to 20 degrees. These cutters are generally made with a spiral angle of about 25 degrees. Milling cutters for aluminum and its alloys are shown in Fig. 2.

Cutting Speeds

In the machining operations already discussed, and in others yet to be treated, wide ranges of cutting speeds and feeds may be used. The particular values for speed and feed are usually dependent on the character of work, type of tool, lubricant used, if any, and the machine on which the work is done. As a rule, aluminum can be machined to best advantage by using the highest speed at which the equipment is capable of operating, with moderate feeds and cuts. General information of speeds, feeds, and cuts can be found in Table 2.

Drilling

In drilling aluminum, it is best to use drills having a large spiral angle with more twists per inch than are to be found on the standard type twist drill. The increased spiral gives more "hook" to the cutting edges and causes the drill to cut more freely. Both of the above-mentioned kinds of drills are shown in Fig. 3.

Speed for drilling aluminum may range up to 600 fpm peripheral. The use of a large number of revolutions per minute for twist drills cannot be over-emphasized, because the actual cutting speeds in feet per minute are necessarily low on most drilling equipment with the smaller sizes of drills.

If the work revolves and the drill is

Fig. 3. Among the tools used to machine aluminum are twist drills, two of which are shown below. (A) Double-fluted or standard twist drill, 24-degree spiral angle; (B) Special double-fluted twist drill, 48-degree spiral angle.

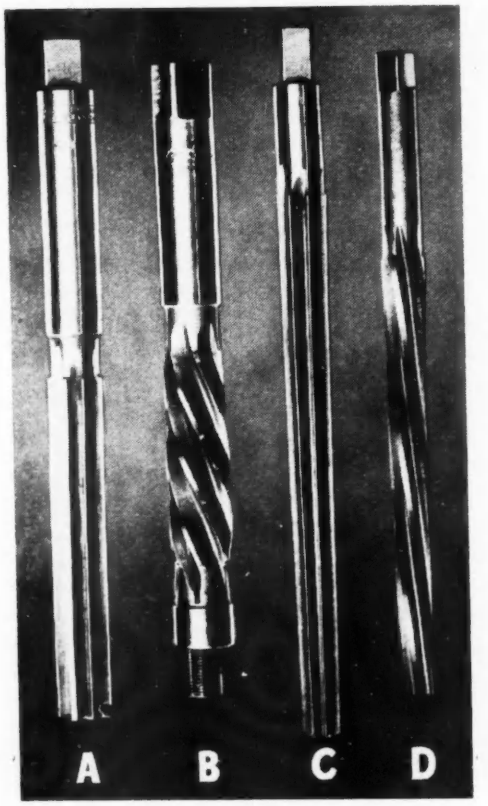


Fig. 4. In reaming aluminum, the four illustrated reamers are used. (A) Plain straight-fluted reamer; (B) Spiral-fluted expansion reamer; (C) Straight-fluted taper reamer; (D) Spiral-fluted taper reamer.

stationary, the straight-fluted drill will often give better results than the spiral-fluted drill. Most jobs can be done satisfactorily if the drill point is about 59 degrees. The lip clearance of 12 to 15 degrees may be increased when the feed is heavy or the material is soft.

No cutting compound is required often when drilling thin material. However, when drilling deep holes, a copious quantity of cutting compound should be applied, and it may be necessery to withdraw the drill from the hole occasionally to apply the compound to the drill point and to dispose of the cuttings.

Reaming

Most of the different types of reamers may be used for aluminum, and are illustrated in Fig. 4. Because flutes spiralled in the direction of the rotation of the tool feed into the work too rapidly, reamers with the spiral opposite to the direction of rotation are generally preferred. In some cases reamers with the alternate teeth spiralled in opposite directions have been found advantageous.

Machine reamers less than two inches in diameter may be operated at cutting speeds up to 400 fpm. for reaming straight holes. For tapered holes, speeds up to 300 fpm. may be used. Holes that are to be reamed should always be slightly undersize, so that the reamer has a definite cutting action. If the hole is too near the finished size, an undesirable burnishing action may result.

Saws

Circular saws and band saws can be employed to the best advantage for sawing aluminum and the aluminum alloys when the saw teeth have considerable top rake and some side rake. Since machining and sawing are both cutting operations, it should be emphasized that the same principles which govern the shape of cutting tools for aluminum should be applied, as far as practical, to saws for aluminum.

The saws should be of the alternate side-rake type or of the chip-breaker type; that is, with teeth of alternate square and beveled-corner profile. This latter type is shown in Fig. 5. In either case the best results can be obtained if the teeth have a top rake of 10 to 25 degrees, and if the saws have coarse, well-rounded gullets in order to prevent the chips from sticking to the saws.

High speeds and relatively fine feeds are best when sawing aluminum with either a circular or band saw. The former type generally operate at 8000 to 15,000 fpm. peripheral, while the band saws move at 2000 to 5000 fpm. When heavy sections are sawed, a lubricant is used. This may be a mineral-base oil thinned with kerosene, a soluble-oil cutting compound, a paraffin, or a heavy grease.

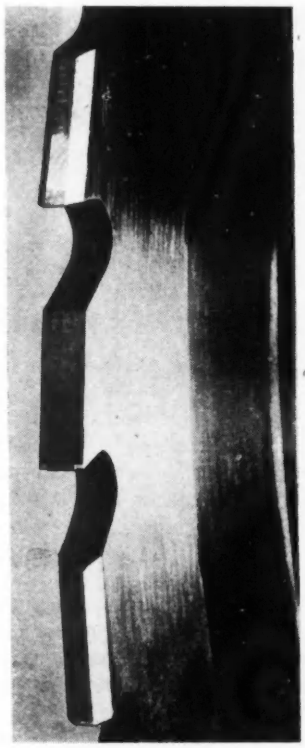


Fig. 5. For sawing aluminum, the above chip - breaker type saw is favored.

Files

When filing aluminum alloys, the single-cut type has been found to be effective. A curved-tooth file with coarse, deeply cut teeth is best for heavy work, when removing a considerable amount of stock. For finish filing, on small work, a long-angle lathe file with a side rake of about forty-five to fifty-five degrees should be used. This type gives a better cutting edge, while the long angle also serves to force the filings free from the teeth.

Files with single-cut teeth and comparatively small side-rake, tend to clog and must be frequently cleaned. The same type of file with medium to coarse teeth will produce better results. Such files, however, should be used with a side sweep, as this will help to overcome their tendency to clog. Double-cut types of files clog too readily to be employed satisfactorily in filing aluminum and aluminum alloys. For some types of work, filing can be accomplished more advantageously with machine oil on the teeth of the file. Chalk rubbed on the teeth of the file also tends to prevent clogging.

Cutting Compounds

When machining free-cutting alloys, as are shown in Type I, Table II, cutting compounds frequently are not used. This is especially true when performing roughing operations. When heavy cuts and feeds produce excessive heat, however, a cutting compound should be used, and often the type of compound that is essentially a coolant will be satisfactory. For this purpose, soda water or soluble oil is generally employed. This type of compound is widely used for milling, drilling, and sawing operations. In other cases it may be desirable to use a mixture of lard oil and kerosene.

Where the cutting compound must have more definite lubricating characteristics, several possibilities exist. One of these is a cutting lubricant prepared from mineral oil, with the addition of 5 to 10 per cent fatty oil, such as lard oil. This is widely used for automatic screw machine work. There are also any number of ready-mixed cutting lubricants intended for use as supplied by the producer. Most of these are usually blended by the user with a low viscosity mineral oil, and the blend may be varied to suit different machining operations. Another excellent lubricant consists of equal parts of kerosene and lard oil, but the proportions may be carried over a wide range for different operations.

Because aluminum differs in many respects from the other commercial metals, a number of points should be emphasized in discussing the machining of the light metal. Aluminum weighs only about one-third as much as steel, and so rather large castings and forgings can be handled without the use of special handling equipment. Owing to its light weight, inertia forces are less in machining operations in which the work moves.

Aluminum alloys have higher coefficients of expansion than many other commercial metals. Therefore, warping and distortion may occur if a cast or forged part is excessively overheated during machining. For precise work, when appreciable heating does occur, the work should be cooled before it is finished to size and calipered so that the required final dimensions may be obtained. Overheating may arise from the use of improperly designed or dull cutting tools, from failure to use a lubricant where indicated, or from the use of heavy feeds or cuts. Distortion is also caused sometimes by improperly clamping the work in the machine.

Ample room for clearance of chips should be provided, and, because of the value of aluminum cuttings and scrap material, they should be protected from contamination. When a premium is paid for controlled purity or composition of scrap, the cuttings from different alloys should be segregated. Finally, in utilizing the high speeds recommended for machining aluminum, the work must be held rigidly and maintained free from vibration if effective results are to be obtained.

New Glass Products for War Equipment

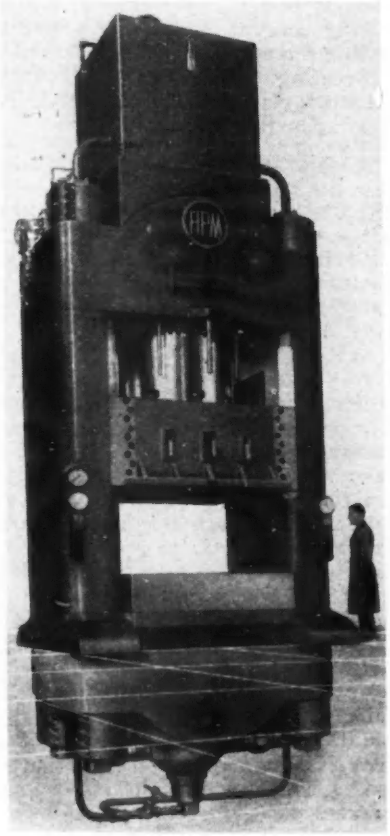
Libbey-Owens-Ford Glass Company has announced a number of new products developed by the company for war purposes. The problem of bending safety glass to the curves and shapes required for installation in airplanes has been solved and today practically all manufacturers of war planes in the U. S. are using laminated safety glass in sections of fighting planes and bombers where both protection and visibility are essential. Other types of glass developed for use in military aircraft are bullet-resisting glass and golden plate glass. The latter solves a major problem of flight in the sub-stratosphere, in that it filters out ultra-violet rays which cause severe sunburn to pilots. A special safety glass has been developed also for gliders and training planes.

The advances made in the technique of bending glass on a production basis will enable the company to afford automobile designers and others much greater latitude in the use of glass in products projected for the post-war period.

Libbey-Owens-Ford during the past six months started the production of optical glass. It also has developed a method for minute examination of selected areas of plate glass to determine their precise optical properties. Both optical glass and selected precision glass are now being supplied by the company for bomb sights, gun sights, and numerous other fire-control instruments.

Two of the company's plants recently began turning out aircraft sub-assemblies, but production in these lines is not expected to assume large proportions until early in 1943, as the various models for which these sub-assemblies are intended are not scheduled to go into large-scale production until next year.

New Production Equipment



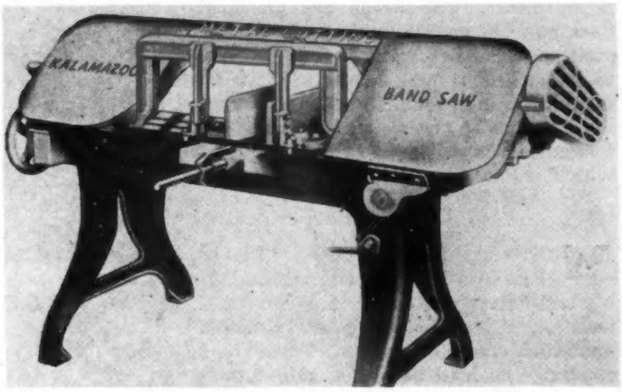
The H.P.M. 3500 Ton Hydraulic Press

ONE of the largest self-contained deep metal drawing presses ever built has just been completed by The Hydraulic Press Mfg. Co., Mt. Gilead, Ohio. This H-P-M FASTRAVERSE press embodies two hydraulic actions, a 3500 ton downward acting die platen and a 1000 ton hydraulic die cushion in the press bed.

The press frame consists of a cast steel head and bed spaced by a pair of cast uprights. Two preloaded tie rods passing through each upright lock the assembly together. The uprights are aligned with the head and bed by special circular keys. The head incorporates the hydraulic cylinder with power ram which actuates the main slide. The slide is guided by beveled ways on the four inner corners of the uprights through adjustable gibs.

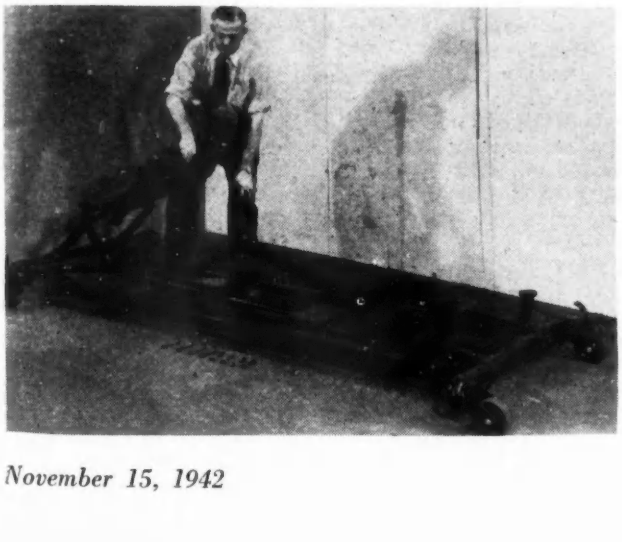
The H-P-M FASTRAVERSE press is capable of drawing heavy steel plate to a depth of 18 inches. More than one drawing operation may be required, depending upon the thickness of the metal and the reduction desired. The press may be operated effectively on varied lengths of stroke and at full pressure for any distance within its capacity. With the die cushion idle, the press can be used for single action pressing such as coining, sizing, straightening, etc.

Only one hydraulic pump is required for operation. Oil trapped in the die cushion cylinder is intensified by the downward acting movement of the main press slide. This intensified pressure produces the resistance force necessary for holding the blank. No compressed air or other outside pressure source is required to operate the die cushion.



The Kalamazoo Metal Cutting Band Saw.

THE metal cutting band saw, illustrated herewith, is now being made by the Kalamazoo Tank and Silo Company, Kalamazoo, Mich. It is equipped with hydraulic frame control which prevents breakage of blades, due to dropping, and enables the operator to stop the frame at any point or slow down its travel by turning a control valve. Feed is by gravity; the machine automatically exerts higher blade pressure on wider cuts, and proper pressure for tubing, etc., is obtained by a cam acting directly on a coil spring.



Motor Rebuilding Specialties Engine Stand. Showing how it may be folded to conserve space in shipping or storage.

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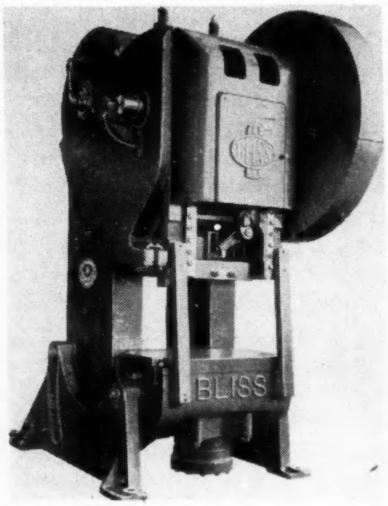
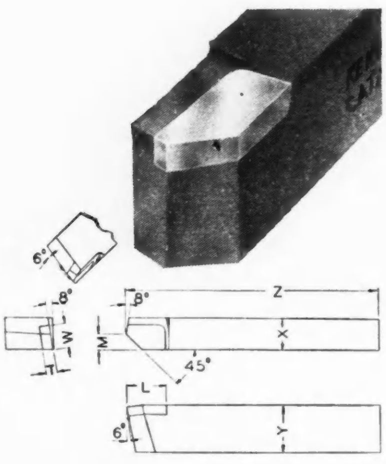


Bliss-Consolidated No. 9 Inclinable Press

A NEW 150-ton inclinable press, the Bliss-Consolidated No. 9, is being manufactured by the E. W. Bliss Co., Brooklyn, N. Y. It is of the geared type with the main working parts enclosed and is equipped with a Marquette pneumatic cushion. All heavily loaded parts are made of a high strength alloy and removable tie bars are used at the front of the frame to keep deflection at a minimum. The press has an open-back gap frame, allowing the feeding of strip stock either right to left or front to back, and it can be inclined 39 degrees to allow completed work to fall, bly gravity, to the rear of the machine. Power is furnished by a 15 hp. motor which is mounted inside the frame.

McKENNA METALS Co., Latrobe, Pa., in answer to the demand for a steel-cutting carbide tool having a lead angle, is announcing new styles 39 and 40 Kennametal tools. These tools combine the lead angle, or side cutting edge angle, with a tip much longer than is customary on carbide tools of this type.

Styles 39 and 40 tools are said to be particularly economical in shell turning operations because only the edge on the lead angle is sharpened and it is easy to maintain the control position of the nose as the tool is reground. The chip breaker is ground only on the section parallel to the lead angle. These tools are available in sizes of ⅛ x 5/16 x ⅝ inch to ⅜ x ¾ x 1½ inch.

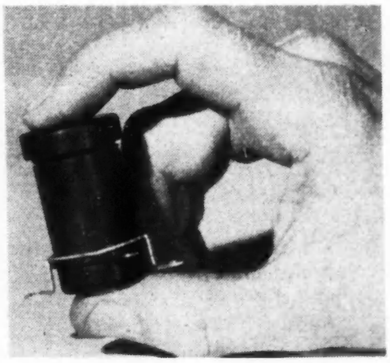


Style 39 Kennametal Carbide Tool

A DUST-TIGHT relay especially designed for aircraft applications requiring high current-carrying capacity without sacrifice of compactness and light weight has been announced by the General Electric Company, Schenectady, N. Y.

The new relay is a solenoid-operated device with the normally-open contacts rated at 10 amperes direct current. These contacts will make or break 30 amperes at altitudes up to 40,000 feet. The coil, contacts, and plunger are enclosed in a dust-tight housing, and the unit is corrosion-proof, meeting 200-hour salt-spray tests as stipulated by various government agencies.

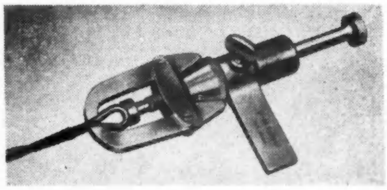
The relay can be furnished in a single-pole, single-circuit form with normally-open contacts or in a single-pole, two-circuit form with one normally-open and one normally-closed contact. The operating coil can be furnished for either 12- or 24-volt d.c. operation. The relay can be mounted in any position on a metal or non-metallic base.



The New G-E Dust-Tight Relay for Aircraft.

When the relay is in the energized or de-energized state, the contacts will remain in the open or closed position without chattering, even when subjected to mechanical frequencies of from 5 to 55 cycles per second at 1/32-inch amplitude (1/16-inch total travel) applied in any direction. The relay is designed for use in an ambient temperature range of from 95 C to minus 40 C, and will withstand 95 per cent humidity at 75 C on 48-hour tests and operate immediately thereafter.

PATRICK-McDERMOTT & Co., Los Angeles, Cal., is making a new universal cable splicing holder that handles cable sizes of 1/16 inch to 7/32 inch without the use of adapters. This device holds the thimble, or bushing, and cable in position by means of two adjusting screws. A thimble holder adjusting screw gives direct contact to the self-seating thimble socket. Turning the screw places the splicing holder in a rotating or rigid position.



The P-M Cable Splicing Holder

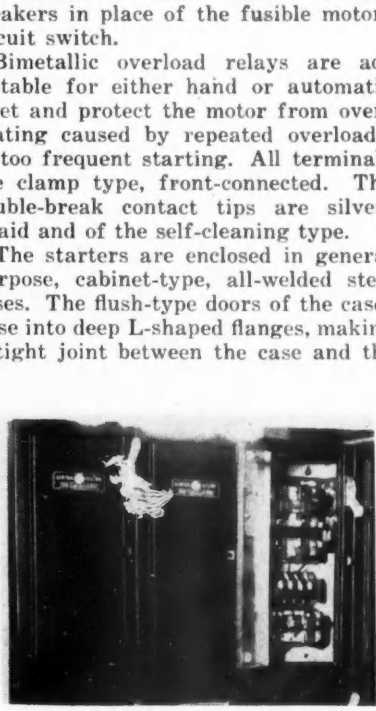
A NEW line of alternating-current combination magnetic starters for full-voltage starting of induction motors up to 7½ hp. has been announced by the General Electric Company, Schenectady, N. Y.

Available only in NEMA sizes 0 and 1 as yet, these starters consist of a fusible motor-circuit switch and a magnetic starter incorporated in one compact unit to conserve space and installation time, to provide greater protection for equipment and operators, and to improve appearance. Also, to facilitate mounting groups of the starters close together, the operating handle is projected through the front rather than the side of the case.

The motor-circuit switch has silver-surfaced, snap-action contacts of the roller type which easily break stalled motor current. New Vystipe fuse clips hold the fuses in place by means of screw fasteners at each end. Forms are also available with thermal circuit breakers in place of the fusible motor-circuit switch.

Bimetallic overload relays are adjustable for either hand or automatic reset and protect the motor from overheating caused by repeated overloads, or too frequent starting. All terminals are clamp type, front-connected. The double-break contact tips are silver-inlaid and of the self-cleaning type.

The starters are enclosed in general purpose, cabinet-type, all-welded steel cases. The flush-type doors of the cases close into deep L-shaped flanges, making a tight joint between the case and the



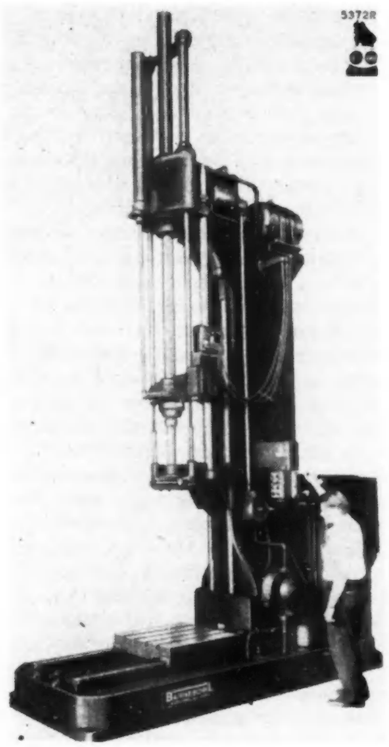
Group of General Electric Combination A-C Magnetic Starters

cover. An interlock prevents opening the door until the switch is OFF.

The starters are completely wired and after being properly connected are ready to operate.

THE quick change speed vertical hydraulic honing machine known as the No. 4014, is being built by the Barnes Drill Co., Rockford, Ill. Six quick change spindle speeds are furnished and the machine is fully equipped with radial ball bearings and Timken roller bearings, including the spindle which rotates on Timken bearings. Push button controls are used for starting, inching, withdrawing and stopping the reciprocating cycle of the spindle.

Reciprocating motion of the spindle is obtained by parallel hydraulic cylinders on opposite sides of the spindle housing. The ten splined spindle is driven by a hardened steel spiral bevel crown gear



Barnes Drill Co., Vertical Holing Machine

which has an inserted bronze hub. Two motors are used, one for the hydraulic system and the other for the spindle drive. A volume regulator, mounted at the side of the column, controls the rapidity of the reciprocating cycles. A pump supplies coolant to the hones, which may be either mechanical or hydraulic type.

TO meet the needs of the many women welders, The General Electric Co., Schenectady, N. Y., has announced a complete line of safety clothing designed especially for women welding operators. Safety, durability, and smart styling are combined in the new

Girl Welding Operator Wearing Several Items of G-E Safety Clothing

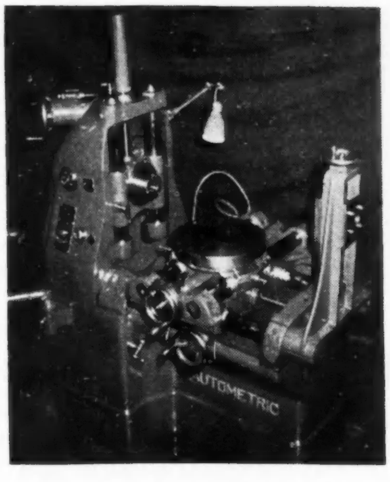
line which is based on the results of an extensive industrial survey of safety requirements for women welders.

Featured in the line are leather sleeves, aprons, jackets, leather gloves, and a special women's head and hair covering. Designed by Sally Victor, one of the country's leading milliners, this head covering protects the hair from sparks and slag and can be used with any of the modern welding helmets.

All items in the line are of high-quality material, comfortable, and light in weight—yet they provide full protection.

JIG boring machines, in a new series of models, are announced by the Kearney & Trecker Products Corp., Milwaukee, Wis. Known as the AUTOMETRIC, they are made in two models, "A" and "B."

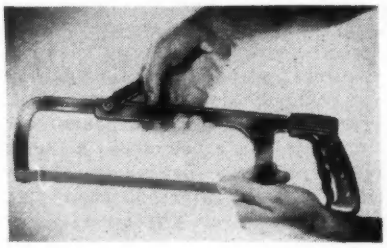
Both models feature hardened, precision ground measuring screws with threads ground from the solid, hardened, ground and superfinished ways, 6 inch dials graduated in .001 inch with verniers reading in ten-thousandths, and mechanical counters reading directly in inches, tenths and hundredths. The machines are equipped with infinitely variable feed control of 0 to 3½ inches per minute.



The AUTOMETRIC Jig Boring Machine, Model "B".

The model "B" machine has an infinitely variable control which provides spindle speeds of 180-1800 r.p.m. A direct reading tachometer indicates spindle speeds. The vertical measuring travel is 10 inches, the traverse measuring travel is 16 inches, and the carriage travel is 13½ inches.

A HACK saw frame of new design has just been introduced by the Victor Saw Works, Inc., Middletown, N. Y. It features a cam-action level-lock by means of which blades are set up or released in a fraction of the usual time. The frame is made of heat-treated



Victor Hack Saw Frame

spring steel with a gunmetal finish and is available with either pistol grip or straight handle. Both handles are molded Tenite. Adjustment is provided for blades of 8, 10 or 12 inches, and blades can be positioned to face in any of four directions.

A NEW small fractional horsepower motor, especially adapted to the operation of aircraft aerial cameras, is announced by the Signal Electric Mfg. Co., Menominee, Mich. It develops 1/120 hp. at 6000 r.p.m., operating on 12 volts. Its other specifications are:

Fractional Horsepower Motor made by Signal Electric Mfg. Co.

weight 14 ounces, diameter of housing 2 3/16 inches, overall length not including shaft 3 7/32 inches, shaft extension 1 inch and shaft diameter 0.1875 inch. The motor is equipped with ball bearings.

Some Timely Technical Papers

SAE National

Aircraft Engine Air Filters

AIR FILTERS, according to Wayne W. Cannon, of Wright Aeronautical Corp., were used on aircraft engines as far back as Lindbergh's flight to Paris, but they were later discarded, because the demand for higher engine power and higher performance of aircraft forced engine manufacturers to omit that part of the induction system outside the engine. The war in the desert has brought home to engine manufacturers the vital necessity of carburetor air filters under adverse conditions, since without them an engine can be operated for only a few hours before piston-ring wear becomes a serious problem. Both the British and the Germans have used filters on their planes in desert warfare. The air filter used by the British consists of gauze supported between layers of wire mesh formed into pleats, accordion-fashion. The object of pleating is to increase the surface through which the air can pass in a scoop of given cross section. In most British installations the filter is inserted in the main air intake without provision for a bypass. An air filter taken from a German Messerschmitt had clam-shell shutters at the front, which could be closed to bypass the air. Considerable sand was found in the intake pipe of the engine, but it was not certain whether this was due to neglect of the pilot to close the bypass when making a landing, or to inefficiency of the filter.

In this country a great deal of work on air filters or air cleaners had been done by the automobile and air-conditioning industries, but most of the designs developed were not practical for aircraft service because they were too heavy or not sufficiently rugged; also because they imposed too much of a restriction on the air flow or because they complicated the induction system too much. Viscous impingement-type filter elements have been found most readily adaptable to aircraft. They consist of knit-wire or knit-metal ribbon sheets, suitably crimped and packed in durable metal frames. The mesh of the sheets becomes progressively smaller from front to rear, and the sheets are sufficiently well supported so the elements will withstand engine backfires without damage. Before it is installed in the induction system, the filter is dipped in engine oil and allowed to drain. The oil entraps and holds the sand, and the filter is easily serviced by cleaning it in gasoline and redipping it in oil. When properly made, viscous-impingement filters will remove about 90 per cent of the sand in the air, at an air velocity of 1000 fpm, without creating a pressure drop in excess of 4 in. of water column. Filter elements of such performance can be built in a variety of shapes. However, flat surfaces are preferred because such filters are easier to manufacture. The thickness of the elements has been standardized at 2 in.

In Fig. 1 herewith is shown a typical filter installation in the air scoop of an airplane engine. It is usually necessary to place the filter element at an angle to get sufficient filtering area. The pressure drop through the filter increases as the angle of incidence decreases, but for angles of incidence in excess of 20 deg. the pressure drop is not very important. Ejection slots are provided in the wall of the scoop immediately ahead of the filter element, and the small amount of air escaping through these slots carries off dirt and free water that may settle in the air scoop or be deflected by the filtering element. Seals are placed at all joints near the filter element and around the alternate air intake.

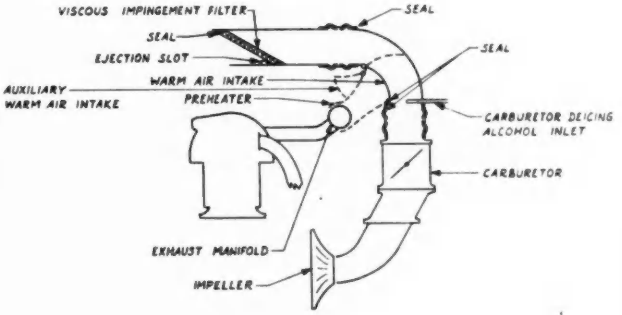


Fig. 1—Showing a typical filter installation in the air scoop of the engine.

The drawing also shows the alternate air intake and a carburetor-air preheater. The dotted lines indicate a shrouded exhaust manifold, the shroud or muff picking up and pre-heating the carburetor air before it enters the induction system. This system may produce very high carburetor air temperatures if there is no admixture of cold air through the main air intake. For this reason an auxiliary warm air valve has been added. This valve can be rigged to a single preheat control in the cockpit so that for the first portion of the cockpit control travel, the auxiliary warm-air valve remains fully open, and does not start to close until the admission valve in the air scoop is fully open. As the cockpit control is moved further toward the full-hot position, the auxiliary warm-air valve closes to give the pilot full use of the preheater.

In an induction system incorporating an exhaust turbo supercharger, the air filter is located on the pressure side of the blower, as shown in the second illustration. With the filter in that location it will have the least effect on the

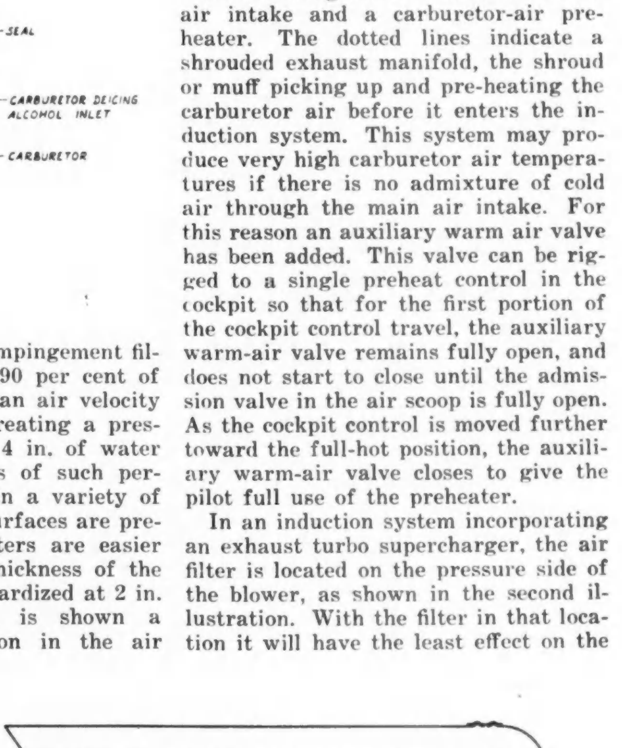
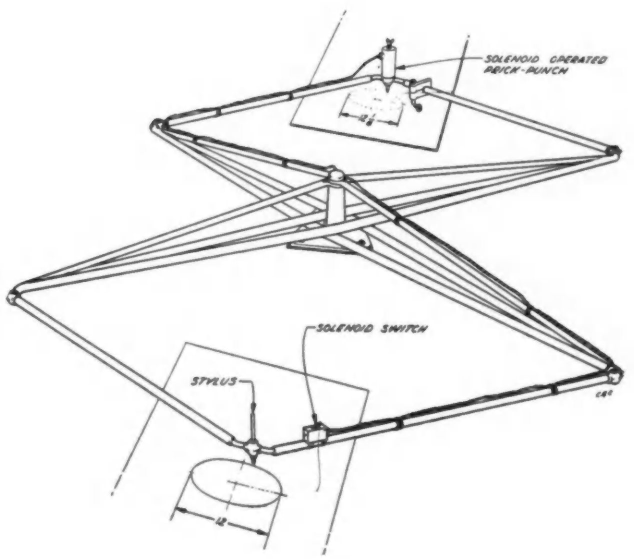


Fig. 2 — Installation of air filter in a powerplant comprising a turbo-charger.

# of Recent Aircraft Production Meeting

operation of the supercharger. Heat control then can be effected by means of the intercooler shutters and, besides, the air flowing through the viscous impingement element normally will be at a reasonable temperature. With a turbo installation it is desirable to be able to stop bleeding air from the pressure side of the supercharger at high altitudes, and controllable flaps therefore are provided at the ejection slots, as indicated in the diagram.



"Shrink machine" used to enlarge drawings to make allowance for die shrinkage.

Master Layouts for Production Use

How Vultee uses master layout for production was explained in a paper by Stanley R. Carpenter of the Vultee organization. By master layout is understood a complete and accurately-scaled full-size drawing on sheet metal, showing all the information required for jigging and tooling of assemblies. It is under the direction of the Production Engineering Department, whose responsibility it is to furnish all the design information required to produce parts. However, the master layout group is very closely associated with the template and tooling departments. Master layout usually is carried on concurrently with engineering layout, and as a rule the master layout is released for tooling purposes before production engineering drawings are released, as the latter are drawn after the engineering layout is completed.

Master layouts are made on metal sheets with specially-prepared surfaces, to permit reproduction by X-ray or some other direct-contact printing process. The layouts are drawn full size, with a tolerance of plus and minus 0.005 in. Lines are approximately 0.002 in. wide and are made with a 9 H pencil.

A control board is set up for sections of the airplane with many separate complete assemblies, such as the powerplant section with its cowling, ducting, engine mount, controls, etc. It is necessary to know the exact locations of these parts as to clearances and alignment.

Loft lines of contoured shapes comprise the majority of master layouts. These often are numerous, and in certain cases they are close together, so that it would be confusing to draw in structural members matching these contours. In that case it is necessary to transfer to another plate certain basic sections needed to show the related assembly of parts. Transfer of contours or irregular center lines are never accomplished by a duplicate layout; instead templates are cut from the original basic lines from which the section is transferred by direct tracing on the new plate around the template outline. A skilled layout man can accomplish this tracing within 0.002 in. error from the template shape. This system of transfer introduces the error in making the template from the original and the error in tracing the outline of template on the new plate, both of which are negligible (less than 0.010 in.). After transfer, lines on the new plate become the basic ones for all future reference of tooling and development. The original loft lines are never used, except as a reference by engineering for checking templates from which transfer sections were made.

At present Vultee is using X-ray for reproduction purposes, but it has another method under development. With the new method, the original master layout is made on a surface coated with phosphorescent paint which may be expected by either natural or artificial light. A copy of the original is made in the usual way by direct contact printing.

Mr. Carpenter stated that, aside from its use in template reproduction for plaster models, the master layout has many other uses. It supplies all locations for drilling drill plates without additional layouts. Shapes of form blocks, shear plates, and punch press dies ready for machining are given by it. Metal stampings and punch-press parts—beads, cutouts, and flanges and trim edges—have their locations established for further tool design. In the case of jigs, base plates with an outline of the parts supply information for locating clamps, positioning members and controlling dimensions. Problems of reference points are eliminated, because any base or new bases not set up on the master layouts may be chosen. They may be safely scaled for convenience in jig building. Reproductions of surfaces limited to single curvature, such as wing skins, may be made on metal of identical thickness, simulating the actual part. Drill fixtures and proper locating points may be established from a print of the true layout. Duplicates of the original furnish exact information for the planning and design of tools and jigs. The master layout furnishes information needed in tool design and planning in a more convenient form than the ordinary production drawings.

Templates for plaster models in the development of drop-hammer dies must

be increased in scale from the sections shown by the master layouts, to account for die shrinkage during the casting process. Kirksite or Zamac dies require an allowance of ⅛ in. in 12 in. for shrinkage. A "shrink machine" has been developed by Howard Thrasher of Vultee Aircraft, for this purpose. The machine, which is shown here, is a clever adaptation of the familiar pantograph. The linkage is mounted entirely on ball bearings and lengths of arms are proportioned to give the desired allowance for change in scale. A print from the original master layout furnishes the basic lines for copy into the shrink template reproduction. It is obtained by indexing a sharp pointed stylus at several different points of the basic line. At each successive point an electric switch is closed to operate an electric solenoid prick punch. A succession of prick punch marks on template stock furnishes a series of points that are connected with a scribed line to give the shrink-template outline.

Spot Welding

A LENGTHY paper on "The Place and Use of Spot Welding in Design and Production of Aircraft," was presented by G. S. Mikhalapov, supervisor of welding research, War Metallurgy Committee, National Research Council. The author stressed the economy of spot welding, holding it to be the most economical of all of the methods ever devised for fabricating sheet-metal assemblies and structures. He claimed, moreover, that in practically all cases the strength of the joint can be made greater than that of the metal itself.

With the tremendous expansion of aircraft production in recent years, the welder industry has developed spot-welders primarily designed for welding aluminum sheet, and welding engineers have developed suitable procedures. In the author's opinion, equipment now available on the market for spot-welding aluminum exceeds in refinement anything ever offered for welding ferrous alloy. On the other hand, owing to the differences in electrical and thermal conductivity, and the much greater difference between the electrical conductivity of the oxide film and the base metal, the spot-welding of aluminum alloy always will be somewhat more complicated than the welding of mild steel and some other non-air-hardening ferrous alloys.

To facilitate spot welding, the parts to be welded should be specially designed, and the author presented sketches of various types of stiffener panel which he classed as preferred, good, fair and impossible or extremely difficult from the standpoint of spot welding. He also showed sketches of a number of good and bad designs of spot-welded joints. The following table, reproduced from the paper, gives recommended minimum weld spacing, edge distances and clearances around the weld for good welding practice. These dimensions constitute a tentative standard of the American Welding Society.

Templet Duplication by Dry Offset Printing

A NEW method of templet duplication by dry offset printing was discussed in a paper by W. A. Collins and J. T. Barnes, of the Curtiss-Wright Corporation's Columbus plant. They said that early in January of the current year it became apparent that Curtiss-Wright would be asked to coordinate and control, through its Columbus plant, a tremendous production program involving the basic SBSC-1 dive-bomber type of plane. Complete planes were to be built in four different plants, two in this country and two in Canada, and subcontracting to the extent of more than 50 per cent of the complete plane was to be resorted to. It therefore became necessary to furnish both integrated plants and subcontractors with information in a form sufficiently complete to insure a reasonable degree of interchangeability of parts from different sources. This called for a method of rapidly reproducing mold loft templets complete with coordinating hole locations. To reduce this apparently tremendous volume of loft layout work.

A number of different methods of reproduction were investigated, and the choice finally fell on offset printing. Offset printing is a form of printing that uses a positive plate to obtain a positive print. In this process a film of ink is transferred from a plate which is an original templet layout, to a rubber blanket, and from the blanket the ink design is offset or transferred to the printing stock. At first some concern was felt regarding the accuracy of the transfer, owing to the elasticity of the rubber blanket, but the fact that offset color printing presses using rubber blankets and printing six colors at the rate of 60,000 finished copies per hour on a continuous roll of paper, with all six colors in extremely accurate coordination, gave assurance that this process was sufficiently accurate for templet duplication.

The process has proved well adapted to the reproduction of templets on a large scale. Twelve men can prepare plates, drill, print and inspect 5000 duplicate copies per week. During a seven-week period when a record was kept, 27,284 templets were reproduced, at an average cost of 0.14 man-hours per reproduced templet, or approximately 21 cents per templet for labor and process cost, not including templet material and overhead charges. The cost of the entire operation, including overhead for crating and shipping, order clerks and templet runners, has amounted to 0.31 man-hours per templet for over 100,000 templets produced. It is figured that the cost of reproduction by the method described is one-seventh that of manual reproduction.

Panelyte Applications

"NEW Applications of Panelyte in the Aircraft Industry" was the title of a paper by C. R. Mahaney, general manager of the Panelyte Division of the St. Louis Paper Co. Panelyte is the trade name for a variety of laminated materials with either wood, fabric or paper base, bonded by phenolic or similar materials, and is now supplied in the form of flat sheets as skin or covering material, as plywood flooring and fuselage doors, fairings, table drawers, stowage boxes, instrument panels and control pulleys. It also is being extensively used for fuel tanks, pushrod housings, and engine cooling baffles.

The flooring, which was developed in cooperation with the Glenn L. Martin Co. and the Boeing Aircraft Co., is a molded corrugated section of the wandering-web type, with or without reinforcement by metal strips, which is molded and laminated to a flat surface sheet in one operation. A non-skid surface is molded into the top side. In recent months a plywood floor has been used in aircraft where great strength is not required. It is built up of resin-bonded aircraft plywood to a thickness of ¼ or 5/16 in. Panelyte sheets are bonded to the upper and lower surfaces of the plywood. That for the upper surface has a rough morocco-surfaced fabric base sheet giving a non-skid effect, while the covering for the lower side is a smooth surface sheet of No. 900 Panelyte.

A skin or covering material for airplane members to take the place of aluminum sheet has been developed with the aid of Vultee engineers. Panelyte Grade 900, it is claimed, can be fabricated in the same manner as aluminum sheet. These sheets are riveted to aluminum ribs and are

(*Turn to page 76, please*)

Recommended Minimum Weld Spacing, Edge Distance, Clearance

	.016	.020	.025	.032	.040	.045	.051	.064	.072	.081	.091	.102	.125
Minimum Edge Distance	3/16	3/16	7/32	1/4	1/4	5/16	5/16	3/8	3/8	3/8	7/16	7/16	1/2
Minimum Spot Spacing	5/16	3/8	3/8	3/8	7/16	7/16	1/2	1/2	9/16	5/8	5/8	3/4	1
Minimum Distance between Rows of Staggered Welds	1/4	1/4	5/16	5/16	5/16	5/16	3/8	3/8	7/16	1/2	1/2	1/2	5/8
Minimum Overlap, Flange Width or "Flat" Required	3/8	3/8	7/16	1/2	1/2	5/8	5/8	3/4	3/4	3/4	7/8	7/8	1
Minimum Unobstructed Area Required to place a Weld Diameter	7/16	9/16	9/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	15/16	15/16	15/16

Note: In case of combinations of uneven thicknesses, the thickness of the next to the heaviest gauge joined is to be considered as the thickness governing the above dimensions.

C M P Controlled Materials Plan

By L. W. Moffett

> **"The test of whether a material control plan is workable comes in its operation. The members of the automotive industry will exert themselves to make this one work. They count, too, on the material producers and the government agencies doing their utmost to make it work . . . This industry's decades of mass production experience dictates, however, that care is needed in operating any such plan to assure flexibility of material flow, so as to keep the hundreds of components of each finished product coming at balanced rates . . . Flexibility is required to meet emergencies and the changing strategic requirements of military operations by putting promptly into production necessary changes, improvements and new products. Flexibility may be jeopardized by the method of handling the paper work under this new plan, but in the evolution of what is otherwise a sound approach, it is hoped any such impediment to balanced mass production of armaments will be eliminated."**
>
> GEORGE ROMNEY
> *Managing director of the ACWP*

AS THINGS stand, industry is governed by more regulations than ever despite the issuance by WPB on Nov. 2 of the Controlled Materials Plan which most people thought would do away with much red tape and paper work. The plan is not effective until the second quarter of 1943 but industrialists will be forced to make organization shifts in the interim to gear their plants to operate under the new material distribution system.

Metal users processing less than $5,000 worth of metals are subject to the "P" orders which assign blanket preference ratings. PRP is to be used until CMP takes hold. Furthermore, the principles of PRP will continue for all Class B or articles subject to the Office of Civilian Supply according to the provisions of CMP. Meanwhile, all material limitation and priority regulations remain in effect. Preference ratings will not die until the beginning of the third quarter for the materials, copper, copper base alloys, aluminum and steel, which are covered by CMP.

CMP forces the development of overall programs and requirements, the balancing of production components, the matching of material supply and demand, and through controlling the three metals will likewise control an estimated 75 to 90 per cent of the country's total production.

The government is going to decide what it wants from industry and when it wants it. Industry is to inform government how much material is needed for military and other requirements and how much can be produced. The government is going to keep books, thus maintaining its demands within industrial capacity and material supply.

The claimant agencies under the plan are: War, Navy, Maritime, Aircraft Scheduling Unit (agent for Army Air Forces and Bureau of Aeronautics) Lend-Lease, Board of Economic Warfare and the Office of Civilian Supply.

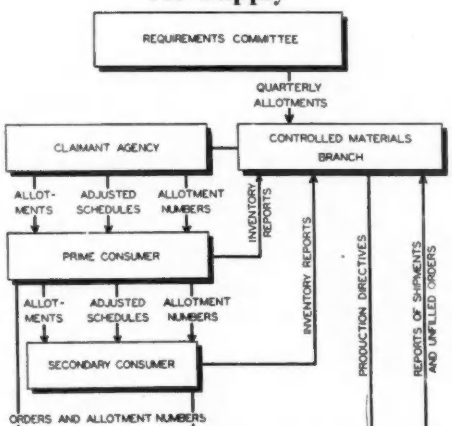
Bills of materials for specific end products will be submitted by prime contractors to the claimant agencies. The claimant agencies will, after adjustment of all tentative estimates, submit material requirements for the controlled material to the WPB Requirements Committee. The Requirements Committee will certify to the claimant agencies allotments of material for direct military purposes.

Prime contractors will make application to the claimant agencies for direct military allotment of controlled materials and to WPB for all others. Prime contractors will authorize the requests for materials for subcontractors limited as to quantity and as to period of consumption exactly as they received their authorization.

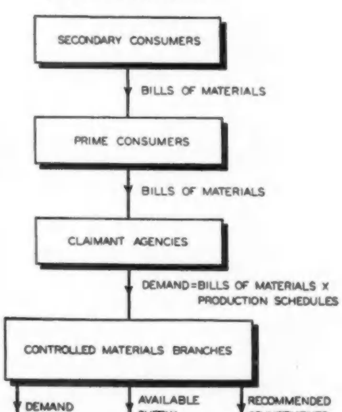
Controversy over who originated the plan and who won in the struggle can be ended by saying that all interested groups originated it and also won out. The plan is a compromise from start to finish. The armed services wanted vertical rationing. They got it. WPB wanted a continuation of the principles of PRP. These were incorporated. The steel industry wanted time and quantity control over materials. CMP has them. The automobile industry wanted scheduling, vertical rationing to the major producers of munitions with the power to allot materials to subcontractors. CMP satisfies this particular. The WPB Aircraft Branch wanted vertical rationing but wanted to direct the prime consumers to designated suppliers. This was done. And those who wanted preference ratings to continue must be satisfied because all other materials can be procured through their use.

No preference ratings will apply to controlled materials after June 30, but during the second quarter of 1943 both allotment numbers under the plan and preference ratings under PRP will be in effect. Preference ratings will continue to apply to fabricated products and not steel products, as defined. Fabricated products are any products not included in the list of steel products. *(Turn to next page, please)*

Flow of Allotments for Supply



Flow of Requirements for Demand



Sub-contractors and sub-suppliers will receive shortened forms of authorizations received by the prime contractors. These authorizations will bear the same allotment numbers as those of the prime contractors. Allotment numbers will indicate the initial of the agency, the program number, the number of the prime contractor's schedule and the month of delivery. An example of a War Department order would be "W-1234-567-16." April, 1943, is expressed by (16) because it is the 16th month after Jan. 1, 1942.

As indicated, materials other than controlled materials will continue to be distributed through the priorities system. Each company receiving an allotment number carrying an allocation of steel will also receive a preference rating for use in obtaining other materials. A preference rating accompanied by an allotment number will be higher than other ratings of the same category, but will not take precedence over a higher rating. For example, AA-3 plus an allotment number is higher than AA-3 without the number but is not higher than AA-2X.

Mills will be authorized to accept orders up to 105 per cent of expected production and the schedules authorized by the claimant agencies to prime consumers may be for as long as one year. The claimant agencies are authorized to make allotments on the basis of declining percentages of allotments established for a current quarter. These percentages are: For the quarter immediately following the one for which a definite allotment has been made, 80 per cent; for the next following quarter, 60 per cent, and for all other quarters, 40 per cent.

Production directives which have been in operations in the Steel Branch for several months, will be employed by the Copper and Aluminum Branches in the future. In this regard, the branch authority is supreme. If a mill receives orders beyond capacity, it must refuse them, and notify the appropriate branch. If a consumer with an allotment cannot place his order satisfactorily, he should appeal to the branch. To prevent duplication, each company operating under PRP will be required to cancel authorizations made in equal amounts for CMP allotments, and the total authorization outstanding at any time will not be permitted to exceed available supply.

WPB has set up three new units to facilitate the operation of the system. The Central Engineering Unit, to be composed of technical men, which has not as yet been set up, will maintain a constant audit and examination of bills of material. The Recording Unit will keep records of the allotments placed with the claimant agencies and inform WPB when allotments placed are in danger of exceeding supply. The Service Unit will answer questions and advise on the operation of the plan.

The exceeding of allotments by a prime contractor is made a criminal offense punishable by a fine of $10,000 or one year in prison or both for each violation. Manufacturers must submit inventory reports to the WPB Materials Redistribution Branch within 15 days after a quarter, provided his inventory is in excess of a specified amount. Special forms will be promulgated for this purpose.

All manufactures have been divided into Class A and Class B products. Class B products whose demands are taken care of by the Office of Civilian Supply as the claimant agency are items normally sold on the open market and those subassemblies or miscellaneous or specialized items of equipment for which individual, specific allotments from claimant agencies to prime consumers and from prime consumers to secondary consumers are deemed impractical. Class A products are the products needed by the claimant agencies other than the Office of Civilian Supply.

The following is a list of Class B products comprising Exhibit II of the plan:

Agricultural machinery and equipment; air conditioning equipment; batteries; bearings, ball and roller; bolts, nuts, rivets, screws and washers; blowers and fans, blast, blower type, exhaust drying, forced draft and industrial dust collecting apparatus; communication equipment; compressors and vacuum pumps, reciprocating, centrifugal, turbo-blowers and rotary; condensers, steam, including surface, jet and barometric; construction machinery and equipment; consumers durable goods; containers; electrical apparatus for internal combustion engines, fasteners, textile and leather; furniture; general industrial machinery other than components of Class A products, including elevators, conveying equipment, industrial trucks, etc.

Generators, electric; hardware; health equipment and supplies; heat exchangers; instruments for indicating regulating and recording temperature, pressure flow; liquid level; humidity, movement, time and electrical quantities; machine tools and metal working machinery; mining machinery and equipment; motors, electric; and motor generator sets; office and service machinery; petroleum machinery; piston rings; plumbing fittings and supplies; plumbers specialties such as fixture fittings and trim; plumbing, heating and cooking equipment; power boilers and auxiliary equipment; power equipment and public utility equipment including electric, gas, water, central heating and other public utility apparatus, and equipment; pumps, power driven except measuring and dispensing pumps; refrigeration, commercial and industrial.

Safety and technical equipment; spark plugs; special industry machinery, including food machinery, rubber working machinery; wood working machinery, etc.; switch gear, panelboards, switchboards, motor controls, switches, circuit breakers and other electrical control equipment and accessories; transformers; transportation equipment (including automotive); turbines, land and marine; valves; welding rods and electrodes; wiring devices and supplies, including electric fuses and pole line hardware and insulators.

The foregoing list of products for which OCS is to be advocate before the Requirements Committee, are the products which WPB will directly control through the issuance of allotments of controlled materials through its industry branches. The list is intended to include certain specified types of intermediate products or component parts which may be included in either Class A or Class B products. For a specific list of civilian end products, reference should be made to the instruction to be furnished regarding types of bills of materials which manufacturers of each

(*Turn to page 66, please*)

Chronological Outline of Controlled Materials Plan

1. November and December, 1942.
Claimant agencies complete the collection of bills of material and estimate requirements, pursuant to instructions from Requirements Committee.

2. January 1, 1943.
Claimants submit requirements to controlled materials branches, with a copy to Requirements Committee, showing controlled materials required, by months, broken down as between (a) production, (b) construction and facilities, and (c) maintenance, repair and operation supplies.

3. January 1 to January 15, 1943.
Controlled materials branches and office of vice-chairman analyze requirements submitted by claimant agencies and make preliminary reconciliation to the extent possible between requirements and supply.

4. December, 1942, and January 1943.
Claimant agencies and prime contractors proceed to develop information necessary in making final allotments, in order to be in readiness for distribution of allotments when made by Requirements Committee.

5. February 1, 1943.
Requirments Committee makes allotment of controlled materials to claimant agencies for second quarter of 1943.

6. February, 1943.
Claimant agencies distribute allotments to prime consumers.

7. February and early March, 1943.
Prime contractors divide up allotments authorized by claimant agencies between secondary consumers, and consumers place authorized orders with suppliers.

8. March, 1943, and thereafter.
Controlled materials branches watch placement of orders on mills and mills' shipments and render assistance in placing orders for consumers of controlled materials who are unable to obtain mill acceptance of authorized orders.

9. July 1, 1943.
Alternative plans and procedures with reference to controlled materials are abolished and thereafter controlled materials are obtainable only under the plan.

Aircraft Is Taking Precedence Over Other Military Production

Almost Half of the Dollar Value of the Automotive Industry's War Orders Devoted to Plane Production

Increasing emphasis on aircraft production as against other military weapons is evident in recent activities by the War Production Board and the procurement branches of the services. Charles E. Wilson, vice chairman of WPB and former president of General Electric Co., has been assigned the task of expediting the aircraft production program. In announcing its 1943 goal of a 7,500,000-man army, the War Dept. recently stated that 2,200,000 men of this total would be in the Army Air Forces. The Navy, too, is boosting its aviation personnel in line with recent naval strategy and experience. Despite the greater stress being placed on aircraft, President Roosevelt recently revealed that the goal of 60,000 airplanes in 1942 would not be reached. This is not due to any breakdown in U. S. production, but to a shift in emphasis to planes with greater hitting power and longer range. Multi-engined bombers and cargo planes and high-powered and heavily-armed fighters will get the call, as these require more material and more man-hours of labor, there has been a consequent lessening of output as compared to the original objectives.

Approximately 45 per cent of the dollar value of the total war orders of the automotive industry are in aircraft classifications, and aircraft commitments total nearly $7 billion. Ten automotive companies are producing airframe assemblies—Fisher Body, Chrysler, Hudson, Ford, Eastern Aircraft Division of GM, Hayes Mfg. Co., Murray Corp., Briggs, Goodyear Aircraft Corp. and Woodall Industries—while two more are preparing to build them. Seven automotive companies are turning out airplane engines on a mass production basis—Allison, Ford, Packard, Buick, Chevrolet, Continental Motors and Studebaker. Two more companies, Nash and Continental Aviation & Engineering, are tooling up for such production. Six types of planes, including bombers, fighters and cargo planes, are scheduled to be manufactured entirely by automotive companies. Other automotive plants are making gunners' turrets, propellers, radios, flight and fire control equipment, aerial cannon and machine guns.

Every five days the automotive industry turns out aircraft products equivalent in dollar volume to 15 heavy bombers, 30 medium bombers and 90 fighter planes. General Motors, which delivered more than $1 billion worth of armaments in the first nine months of 1942, has more than 20 of its 32 manufacturing divisions engaged in aircraft production. GM alone is scheduled to turn out 40 per cent of the aircraft engines on order.

Allison Engineering Division at Indianapolis, which had its V-1710 engine accepted by the Army Air Corps in March, 1937, was one of the first GM divisions to concentrate on aviation. This was the first U. S. liquid-cooled engine to run 150 hours at more than 1000 hp. Allison received its initial quantity order in the summer of 1939, and volume production in its new plant got under way in May, 1940. The original monthly production goal of more than three figures was achieved in December, 1941, shortly after Pearl Harbor, and the total has been expanded since then. The first model V-1710 delivered 1090 hp, but this was stepped up to 1325-hp by June, 1941, and this has been further boosted until it is now the most powerful liquid-cooled engine of its type in the world.

Buick and Chevrolet both are produc-

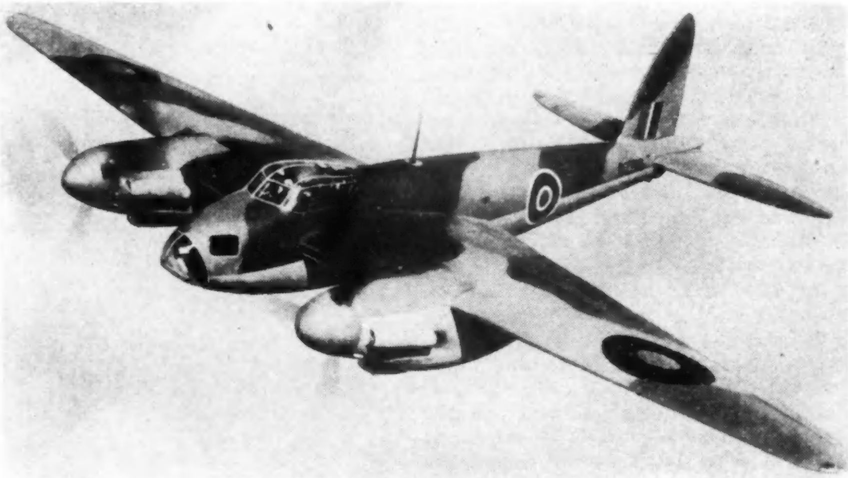
(*Turn to page 64, please*)

Canada Producing Fighting Planes

Production of four newer types of combat aircraft is going forward in Canada. The planes are the four-engine Lancaster bomber, the Mosquito reconnaissance, fighter-bomber, the Curtiss dive bomber and the Consolidated PBY flying boat. The Lancaster and the Mosquito both use Rolls-Royce Merlin engines of the type which Packard Motor Car Co. is manufacturing. Training planes and Hurricane fighters have made up the bulk of Canada's aircraft production in the past, output having reached a total of 400 planes per month.

Col. Jouett to Head Higgins Cargo Plane Plant

Andrew J. Higgins, New Orleans shipbuilder, has been given a contract to produce 1,200 cargo planes for the U. S. Army. They will be of a type already in production. Col. John H. Jouett, president of the Aeronautical Chamber of Commerce, has resigned to direct Higgins' aircraft building activity.



The de Havilland "Mosquito" Reconnaissance Bomber

This new plane is of simple wooden construction and is powered with two Rolls Royce engines. It has the de Havilland three-bladed hydro-matic type propeller. Offensive armament may consist of four 20 mm. cannon and four .303 caliber machine guns.

Automobile Graveyard Steel Analyzed for Alloy Content

American Iron and Steel Institute's Survey to Help Guide Makers of Electric Furnace Steel

By W. C. HIRSCH

That the problem of maintaining uninhibited the flow of steel and other metals to war material manufacturers entails considerations apart from the question of how much is needed and how much is there to do with, is shown by the American Iron & Steel Institute's recent analytical inquiry into the composition of parts used in earlier than 1940 model cars. This post-mortem investigation of the properties of the different kinds of steel that were used in cars now coming more and more into prominence in the scrap market, has become extremely necessary as a guide to makers of electric furnace alloy steel. Nearly all of this goes into war equipment in which compliance with the most exacting standards is the rule.

Of all steel-making processes, the electric furnace product depends for raw material more upon the supply of scrap than do others. In normal times electric furnace operators depended upon well known sources of scrap for their supply. These no longer yield adequate tonnages for the greatly increased war demand and so the automobile graveyards' yield figures more prominently as a source of basic material. It has recently been pointed out that the automotive engineers and metallurgists, who in the first place were responsible for the adoption of certain steels in certain parts, could now lighten the electric furnace man's load considerably by telling him the properties he must expect to encounter when he melts different parts. Paradoxically enough, the technologists who were responsible for the adoption of this or that steel in certain automobile parts, now more likely than not are standing guard that steels entering military and naval construction conform to the specifications of the armed services' engineers. Little wonder, therefore, that the American Iron & Steel Institute's efforts in this directoin are considered of great assistance and the cooperation of others in facilitating scrap identification encouraged.

In line with the emphasis laid on stainless steel in W.P.B.'s latest list of vital war materials that are in inadequate supply, further tightening up in permitted uses has been ordered, some seventy-five products coming under the ban. Dollar-and-cent ceiling prices, at levels close to those in effect during the first half of 1942, have been announced for chrome ores. Maximum prices of ferromanganese have been slightly revised. Maximum prices governing the sale of idle or frozen stocks of cadmium to the Government's stock pile have been established, Udylite Corporation, Detroit, having been appointed as the Government's Metals Reserve Company's agent for assisting in carrying out the cadmium conservation program.

In the opinion of some market observers, the stockpile of zinc under control of the Metals Reserve Company is growing to more reassuring size, facilitating the fulfilment of heavier munition requirements, said to be imminent. Lead continues to be in sufficient supply to justify its being recommended as a substitute for other, more difficult to obtain metals.

Shipments of War Goods From Industry Increase

Shipments of war goods from plants of the automobile industry reached $537,090,000 in August, an increase of 126.1 per cent over last February.

These figures, released today by R. L. Vaniman, chief of the War Production Board's Automotive Branch, are derived from reports on 396 plants owned by 133 companies. This group of companies—seven major automobile manufacturers, eleven truck firms and 115 parts producers—represents approximately 68 per cent of the entire industry.

The number of wage earners in the 396 automobile plants in September was 659,411, an increase of 2.7 per cent over August, and an increase of 30.6 per cent over last February.

Total shipments, including shipment of parts by sub-contractors to prime contractors, rose for another consecutive month in August, reaching a total of $566,013,000. This compares with $540,284,000 in July, $494,113,000 in June and $427,598,000 in May.

Backlog orders in the hands of prime contractors only at the end of August exceeded $12,370,000,000, made up of: Automobile companies, $9,578,000,000; truck companies, $1,625,000,000; and parts companies, $1,167,000,000. The industry estimates that at the rate of August shipments it will require 26 months to complete both prime and subcontract orders now on hand.

Reports by the auto plants to WPB showed the average weekly wage per worker in September was $52.91 compared to $54.24 in August. Yearly payrolls at the present rate would amount to $1,814,228,000.

Russia to Get Ford Tire Equipment

Purchase and transfer of the machinery and equipment in the Ford Rouge tire factory to Soviet Russia has been arranged between the U. S. Government and the Ford Motor Co. Under the arrangement, which followed brief negotiations between Edsel B. Ford, company president, and William M. Jeffers, federal rubber director, the bulk of the machinery in this up-to-date tire making plant will be shipped to Russia under the Lend-Lease program to provide tires for Russian military vehicles. However, some of the equipment may be retained in the U. S. to manufacture special rubber equipment for the war effort.

The Ford Rouge tire plant was completed Jan. 30, 1938, and at the time was regarded as one of the most advanced tire manufacturing establishments in the world.

Official British photo from A...

"Churchill"

Britain's new infantry tank, shown here on maneuvers, is called the "Churchill." It is so heavily armored that it can be used as a pill-box, has 6-pounder guns, and can move along at a startling speed.

Ford Motor Co. and the UAW-CIO Sign Contract for Duration of War

New Pattern Set for Labor Relations in the Industry. General Motors Almost 100 Per Cent Organized

Ford Motor Co. and the UAW-CIO have signed a contract for the duration of the war, except for wage clauses, and thus set a new pattern for labor relations in the automotive industry. Previously, most union contracts were renewable on an annual basis. The Ford contract, signed Nov. 4, retains the union shop and dues checkoff and provides for reopening of wage issues every six months to make any revisions consistent with any changes in the government's wage stabilization policy. The War Labor Board refused the 115,000 Ford workers any blanket wage increases based on the "Little Steel" formula in a decision announced Oct. 13 but did allow a more liberal bonus arrangement which will grant Ford employes an estimated $9,600,000 annually.

The new Ford contract also provides for an impartial umpire, similar to the one who settles certain disputes under the General Motors-UAW-CIO contract.

"The umpire system will protect both management and employes against any injustices by providing for a final and binding disposition of any grievances or disputes which cannot be settled otherwise," said Richard T. Leonard, director of the UAW-CIO Ford Dept., who signed for the union. Harry Bennett, personnel director, signed for the company. A supplemental agreement covering wages and other economic issues within the framework of the WLB decision is being drafted and any disputes arising out of this will be resubmitted to the WLB. The Ford-union dispute was certified to the WLB last June 25, the previous contract having expired June 20.

A dispute over staggered work schedules and Sunday work caused the loss of 10,000 man-hours of production in three departments of the Ford foundry a week before the new contract was signed. The union accused the company of instituting a "trick swing shift arrangement" without consulting union leaders and charged the company was trying to avoid payment of premium pay for Sunday work.

In its report for the first nine months of 1942, General Motors revealed that it had allocated $11,800,000 for wage adjustments and vacation allowances retroactive to April 28 under the terms of the WLB decision of Sept. 18 in the contract dispute with the UAW-CIO. The Aeroproducts Division of GM recently voted for the UAW-CIO 1303 to 308 for no union. Another NLRB election at the new Oldsmobile Division of GM at Kansas City also was won by the UAW-CIO, which out-polled the UAW-AFL. This division, an amalgamation of the former Chevrolet and Fisher Body divisions in Kansas City, eliminated the UAW-AFL local at the latter plant and leaves that union with only one plant in the far-flung GM organization. The lone UAW-AFL survivor is the New Departure Division at Meriden, Conn., while the UAW-CIO claims 99 GM plants and is seeking elections in two more, the Delco Appliance and Rochester Products divisions at Rochester, N. Y.

Following hearings held in Los Angeles, the West Coast aircraft wage stabilization case has been referred to the WLB, which will make an announcement by Dec. 1. Management representatives asked for a flexible job classification system that would recognize and reward individual merit through production incentives. A range of rates also was sought where workers are employed on several different jobs. Other management requests were for no general wage increase, pay adjustments for inequalities within separate plants and within the industry, automatic time increases for beginners and a wider range of merit increases for the upper brackets of skilled workers.

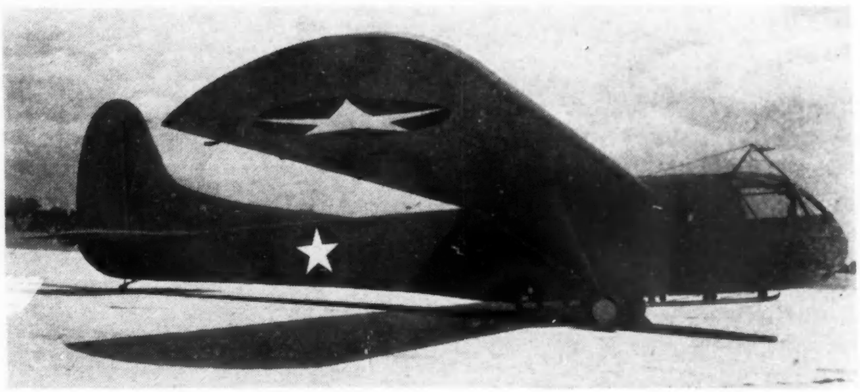
The labor demands as stated by Richard T. Frankensteen, UAW-CIO aircraft director, included elimination of the present job classification system, granting of two weeks' vacation with pay or a compensating bonus, a 10-cent premium for the second shift and 15-cent premium for the third shift, overtime and holiday pay consistent with President Roosevelt's executive order. Frankensteen also demanded the adjustment of wages to eliminate inequalities between the aircraft plants and other California war industries. He pointed out that California shipyard workers averaged $58.14 for 43.5 hours work per week in August while aircraft workers averaged $44.95 for 46.6 hours work. Aircraft workers in Michigan received $56.08 for 43.3 hours work per week in September, while Michigan automobile workers received $54.60 for 43.7 hours work per week in the same month. Frankensteen asserted that the California differential between aircraft and shipbuilding caused a 5 per cent monthly employment turnover in aircraft plants and that 15 per cent of the workers referred to aircraft jobs by the U. S. Employment Service turned them down because of the wages.

Technical Services Branch Discontinued

The Processing Unit of the Tank and Combat Vehicle Section, and the Ordnance Priorities Unit, both formerly part of the Technical Services Branch, are now operating under the control of the Automotive Branch of the War Production Board, under an administrative order announced today by the Director General for Operations. The change was effected following the discontinuance of the Technical Services Branch.

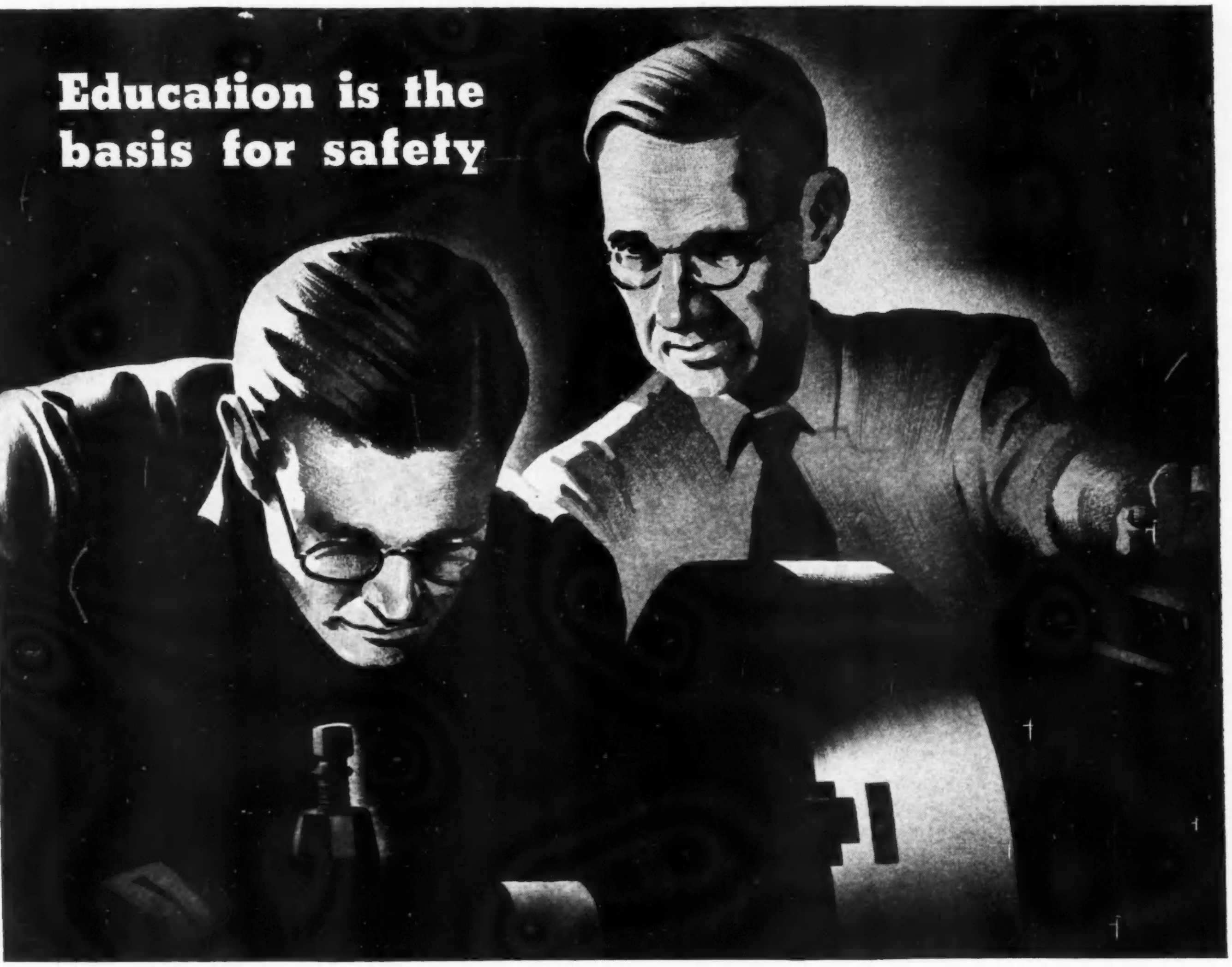
Donovan Promises Storage Batteries

J. J. Donovan, assistant chief, automotive branch, WPB, addressing the convention of the Association of American Battery Manufacturers, stressed the fact that WPB intends to do all in its power to see that sufficient batteries are manufactured to maintain present automotive transportation, including passenger cars, in accordance with the necessity brought out by the Baruch report. Consequently, the average motorist should experience no difficulty in securing a new battery when his present one is no longer usable. Mr. Donovan stressed the fact that the purchaser must turn in an old battery in order to secure a new one.



Ford War Glider

Transport glider, designed to carry 15 invasion-equipped soldiers, to be made by the Ford Motor Co.



Information supplied by the National Safety Council

Labor, particularly inexperienced labor, cannot be expected to recognize the full penalties of carelessness in the shop. Management has assumed the responsibility of supervising safety measures, and has cooperated in establishing sound safety rules.

Nevertheless, the large increase in labor personnel due to war needs, plus the influx of inexperienced men, have resulted in a substantial increase in lost time accidents.

Even assuming that the obvious safety measures with regard to operating machinery, electrical equipment and shop traffic have been installed, two factors — education and eternal vigilance — determine the real effectiveness of any safety program.

Both are the responsibility of the supervisory staff, from foremen up. The foreman who does a thorough job of educating his particular group in safety rules and cooperative enforcement has done much to cut down accidents. Management that takes an active interest in both safety education and the enforcement of safety measures has taken a great step forward in reducing wastage of irreplaceable production time.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

MOLY

Climax Mo-lyb-den-um Company
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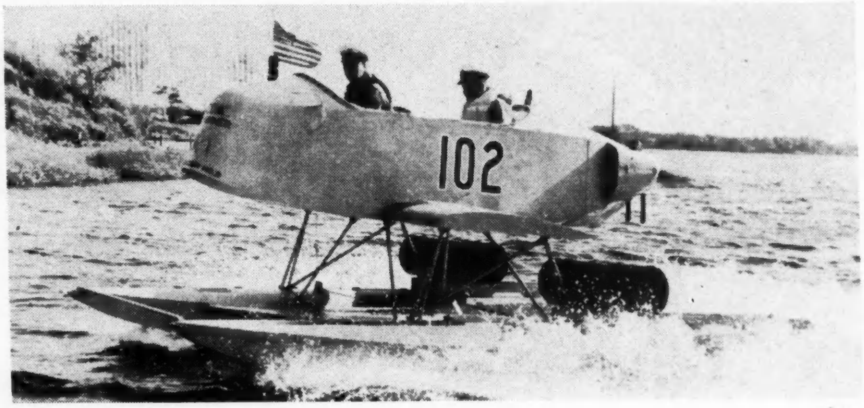


Acme

"Sea Skimmer"

Designed to avoid under-water propeller noise which could be heard by submarines, this sub-chaser can travel at the rate of fifty miles per hour, according to its designer, Antoine Gazda. It is armed with four depth charges which can be replaced by torpedoes and a 20 mm. cannon.

MEN . . . . . .

I. S. Randall has been given a leave of absence from his duties as assistant to the board chairman of Transcontinental & Western Air, Inc.,, to become general manager of the newly formed Aircraft War Production Council, East Coast, Inc.

J. E. Adams, general 'manager of the merchandising division, has been elected vice-president of Toledo Steel Products Co.

Allen P. Livar, formerly chief heating engineer, has been named chief engineer of the Airtemp Division of Chrysler Corp.

Thomas H. Corpe has been appointed general sales manager of Elastic Stop Nut Corp.

Edward G. Bern, formerly regional vice-president of American Airlines, Inc., has been appointed sales manager of Hughes Aircraft Co., Culver City, Cal.

John Berry, Jr., formerly assistant treasurer, has been named to the new post of comptroller of Bell Aircraft Corp.

Brig.-Gen. John K. Christmas, assistant chief of the Ordnance Dept. Tank-Automotive Center, Detroit, has been awarded the honorary degree of doctor of science by Lafayette College.

R. S. Pope, director of personnel at Goodyear Aircraft Corp., has been named personnel director of Goodyear Tire & Rubber Co. He succeeds **Fred W. Climer,** who has joined the War Production Board as director of joint management-labor committee production drives. **Frank J. Carter,** formerly general superintendent of the Goodyear plant at Sao Paulo, Brazil, will succeed Pope as director of personnel at Goodyear Aircraft Corp.

Charles E. Wilson, president of General Motors Corp., has been elected president of the Detroit Industrial Safety Council. **V. A. Olsen,** general manager of the Detroit Transmission Division of GM, is chairman of the board.

T. E. Tillinghast has been elected president of United Aircraft Service Corp., service subsidiary of United Aircraft Corp. He succeeds **Eugene E. Wilson,** president of United Aircraft Corp., who resigned.

Joseph J. Donovan, formerly head of the Replacement Parts Section, has been named assistant chief of the Automotive Branch of WPB. **R. C. Rodine** will succeed Donovan as head of the Replacement Parts Section. Rodine formerly was assistant head of the parts and replacement department of Ford Motor Co.

Lieut.-Col. Elmer J. Jantz, executive officer of the Fort Wayne Ordnance Motor Supply Depot, has been advanced from major to lieutenant-colonel.

C. H. Matthiessen, Jr., assistant director general for operations, resigned from his WPB post effective Nov. 1. He will continue to serve WPB in some capacity on the Pacific Coast from his home at Pasadena, Cal. He went to Washington in February, 1941, as executive assistant in the general products group of OPM.

Albert Bradley and **Ormond E. Hunt,** vice-presidents and assistants to President C. E. Wilson, have been elected executive vice-presidents of General Motors Corp. **E. J. Johnson,** vice-president in charge of the Dayton and Eastern Aircraft divisions, has been appointed a member of the war administration committee.

Farrel-Birmingham Co., Inc., of Ansonia, Conn., announces the appointment of **Edward S. Coe, Jr.,** as manager of its New York office at 79 Wall Street, to succeed E. H. Thomas, recently deceased.

Lee J. Eastman, president and general manager of Packard Motor Car Co. of New York, has announced his retirement from active Packard duty. He is replaced by **R. W. Carson,** who becomes vice-president and general manager of the New York company. Its presidency is assumed by George T. Christopher, president and general manager of the parent corporation, Packard Motor Car Co. of Detroit.

Elmer P. Guth has been appointed to the staff of field service engineers of Pesco, Cleveland, Ohio, a division of Borg-Warner.

The Twin Disc Clutch Co., Racine, Wisc., announces the appointment of **John B. Jenkins** as manager of the Hydraulic Division, Rockford, Ill.

Thompson Products, Inc. has announced the appointment of **Elmer E. Stuart** as assistant treasurer. He was formerly auditor.

E. P. Barry has been appointed coordinator of Plants for the Chicago Pneumatic Tool Co. Mr. Barry was formerly with Glenn L. Martin Co., Baltimore, Md.

T. Lee, Jr., director of United Air Lines' Boeing School of Aeronautics, Oakland, Calif., has been given leave of absence to become a major in the Army Air Forces Technical Training Command.

Keystone Carbon Co., Saint Mary's, Pa., announces the appointment of **George B. Shaw** as sales engineer.

Floyd Todd has joined the laboratory staff of Quaker Chemical Products Corp. of Conshohocken, Pa., in a research capacity.

Business in Brief

***Written by the Guaranty Trust Co., New York, Exclusively for* Automotive and Aviation Industries**

Further advances in general business activity are reported. The seasonally adjusted index of *The New York Times* for the week ended October 24 rose to 131.7 per cent of the estimated normal, as compared with 129.8 a week earlier and 127.5 a year ago. The index of *The Journal of Commerce,* without seasonal adjustment, for the same period advanced to 131.2 per cent. of the 1927-29 average, a new war-time peak, from 130.6 for the preceding week.

Department store sales during the final week of October, as reported by the Federal Reserve Board, were 14 per cent above comparable levels last year; and for 1942 thus far the corresponding gain is 10 per cent.

Railway freight loadings during the week ended October 31 totaled 890,469 cars, 1.4 per cent less than the number for the week before and 0.5 per cent below that for the comparable period last year.

Electric power output increased more than seasonally in the same period and was 11.7 per cent greater than a year ago, as against a similar excess of 12.3 per cent a week earlier.

Crude oil production during the last week of October averaged 3,901,150 barrels daily, 16,200 barrels below the figure for the preceding week and 165,050 barrels less than the average output recommended by the Office of the Petroleum Coördinator.

Average daily production of bituminous coal during the week ended October 24 was 1,889,000 tons, as compared with 1,900,000 tons in the week before and 1,783,000 tons a year ago.

Engineering construction contracts awarded in the week ended November 5 totaled $137,000,000, more than triple the comparable figure last year, according to *Engineering News-Record.* For 1942 to date, the total is 60 per cent greater than the corresponding amount in 1941—with public work 88 per cent higher than a year ago, as against a drop of 52 per cent in private contracts.

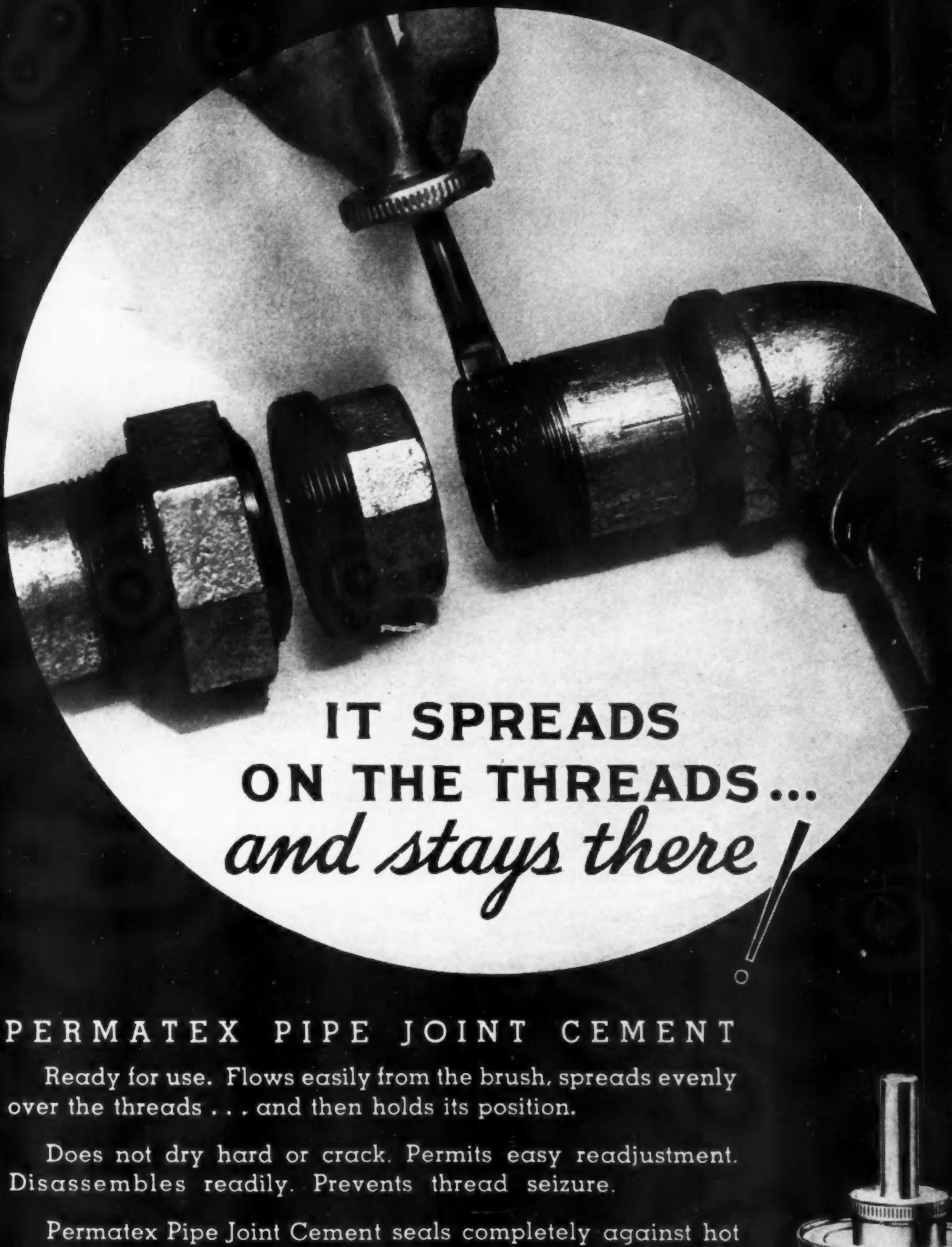
Professor Fisher's index of wholesale commodity prices for the week ended October 30 stood unchanged at 108.4 per cent of the 1926 average, as against 98.3 a year ago.

Member bank reserves decreased $35,000,000 during the week ended November 4, and estimated excess reserves declined $40,000,000 to a total of $2,120,000,000. Business loans of reporting members were reduced $31,000,000 in the preceding week and stood $238,000,000 below the total a year earlier.

CALENDAR

Conventions and Meetings

Natl. Industrial Chemical Conf. & Exposition, Chicago ....Nov. 17-22
Natl. Chemical Exposition, Chicago, Nov. 24-29
Amer. Society of Mechanical Engrs., New York City, Annual Mtg. Nov. 30-Dec. 4
Highway Research Board, St. Louis, Mo. ....Dec. 2-4
SAE Air-Cargo Engineering Mtg., Chicago ....Dec. 8-9
SAE War Production-Engineering Mtg., Detroit ....Jan. 11-15



PERMATEX PIPE JOINT CEMENT

Ready for use. Flows easily from the brush, spreads evenly over the threads . . . and then holds its position.

Does not dry hard or crack. Permits easy readjustment. Disassembles readily. Prevents thread seizure.

Permatex Pipe Joint Cement seals completely against hot and cold water, steam, salt water, illuminating gas, lubricating oils, fuel oils, gasoline, gasoline vapor, kerosene, ethylene glycol, glycerine and numerous other liquids and gases.

Extensively used on threaded connections and flange surfaces of pipe lines, pumps, tanks and similar equipment wherever pressure-tight, leak-proof unions are required.

PERMATEX COMPANY, INC., Sheepshead Bay, N. Y., U. S. A.

Mac Short, vice-president in charge of engineering at Vega Aircraft Corporation, is the 1943 Presidential Nominee of the Society of Automotive Engineers.

Aircraft Experts Visit Great Britain

A group of nine U. S. aircraft production experts, headed by T. P. Wright, director of aircraft production for WPB, recently completed a two-week tour of aircraft plants in Great Britain. Other members of the party were A. G. Herreshoff, chief research engineer of Chrysler Corp.; W. K. Ebel, vice-president and chief engineer of the Glenn L. Martin Co.; P. G. Johnson, president of Boeing Aircraft Co.; Charles Marcus, vice - president in charge of engineering of Bendix Aviation Corp.; S. A. Stewart, general manager of Hamilton Standard Propeller Division of United Aircraft Corp.; I. M. Laddon, vice-president and chief engineer of Consolidated Aircraft Corp.; J. Carlton Ward, Jr., president of Fairchild Engine & Airplane Corp., and G. E. Welty, of Aluminum Co. of America.

Stanicut Cutting Fluids

In keeping with the demands of the war program, the Standard Oil Co., of Indiana, has introduced a simplified but comprehensive line of cutting fluids bearing the trade name—"Stanicut." The new line of cutting fluids includes certain of the products developed in recent years, with the addition of a number of chlorinated materials, as well as a group of heavy duty soluble oils intended for heavy metal cutting operations.

An important feature of the new line is—control of odor, marking improved working conditions, with the introduction of stabilizers for the sulfurized mineral oils.

The range of Stanicut cutting fluids is intended to cover the many specialized problems encountered in the war production program, permitting the use of specific grades suited to individual metal cutting operations.

Accessory drive for aircraft engines

Under the direction of D. R. Pobjoy, a well-known aircraft engine designer, Rotol Airscrews (a British concern intimately associated with Rolls-Royce and Bristol Aeroplane Co.) organized some while back a special department to undertake the development of engine auxiliaries. Concentrating initially on a driving unit or gear box that would relieve the engine of a number of projections and facilitate the installation and maintenance of auxiliary drives, the department has produced a unit termed the Rotol Universal Gearbox.

In brief particulars issued as to its construction it is said to be applicable to practically every type of aircraft, either in front of or behind the fireproof bulkhead, driven by a shaft and flexible coupling through alternative drive inputs, one vertically above the other. In the example illustrated the two horizontal drives on each side have standard flanges for the fitting of various types of pump and diagonal drives above for two generators or other items of accessory equipment. The unit will carry, however, as many as seven pumps of various kinds, if desired, as well as two generators. It embodies its own oil circulating pump, a detachable half-speed unit, large capacity breather, driving pads vented to the atmosphere and provision for driving generators in either a horizontal or a vertical position. All shafts run in ball bearings.

Obituary

Charles H. Norton, 91, long associated with Norton Co., Worcester, Mass., died Oct. 26 at his home, Sharpenhoe, Red Stone Hill. Mr. Norton first became associated with Norton Co. in 1900 when the Norton Emery Wheel Co. founded the Norton Grinding Co. with Mr. Norton as designer and chief engineer. When Norton Grinding Co. was merged with Norton Co. in 1919, he became chief engineer for the machine division. He has not been actively associated with the company for a number of years because of his advanced age.

—

Earl H. McCarty, 56, former president of the Nash Motor Co., died suddenly Nov. 2 at his home in Delray Beach, Fla. McCarty was president of Nash from 1931 to his retirement in 1936. He joined Nash in 1922 as assistant sales manager and became vice-president in charge of sales in 1924. He retired for a year in 1929 but returned in 1930 as vice-president and general manager.

—

John J. Daniels, 62, treasurer of the Divco Twin Truck Co., Detroit, died Nov. 2 at Detroit. He had been with the company since 1926.

—

C. Arden Yinkey, 62, former automotive advertising executive, died at Detroit Oct. 29 following an operation. He was at one time a vice-president of the T. F. MacManus Advertising Agency and later associated with Campbell-Ewald Co., Arthur Kudner, Inc., and the Zimmer-Keller Agency.

—

James H. McCollum, 67, inventor of the Bristol single-sleeve-valve air-cooled airplane engine, was found dead Oct. 25. His son said that Mr. McCollum had been under a doctor's care recently.

—

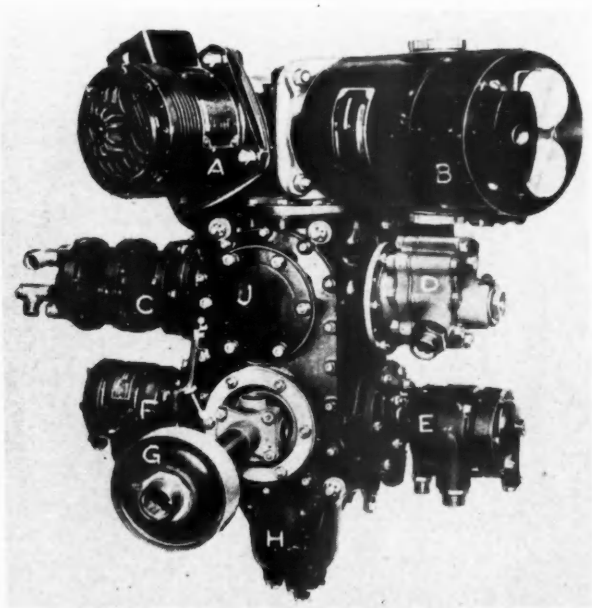
George B. Upton, 60, professor of automotive engineering at Cornell University for 36 years, died Oct. 29 at Ithaca, N. Y. He was a member of the National Advisory Committee on Aeronautics in World War I.

—

George N. Armsby, 66, board chairman of Curtiss-Wright Corp., died Oct. 25 in New York City. He also was a director of Sperry Gyroscope Co., Ford Instrument Co. and Vickers, Inc.

—

Leigh C. Bloomfield, former president of the Jackson Motor Shaft Co., died suddenly Oct. 23 at his home in Jackson, Mich.



Rotol Universal gearbox with typical engine auxiliaries.

- A 500 watt alternator
- B 1000 watt generator
- C R.A.E. compressor
- D Turret pump
- E & F Vacuum pumps
- G Drive shaft (single universal type)
- H Oil sump with circulating pump
- J Alternative drive input

HYDRAULIC GIANT

for Flying Fortress

CLEARING TRIPLE ACTION HYDRAULIC PRESSES /ITH THE DOUBLE GUIDED PUNCH SLIDE FOR PRECI- ION FLYING FORTRESS FUSELAGE DRAW WORK.

These presses are distinguished by being arranged r every combination of pressing actions, all with fully utomatic cycles. They may be adjusted to operate as ngle action presses for use with rubber pad, or with die ushion. They can be changed quickly and easily to t as double action presses with or without die cushion. y another easy adjustment they will give triple action peration with an upward power stroke by the third ction in the bed.

Other outstanding features are: Individually adjustable blankholder pressures in each corner of blankholder, that are controlled from floor level, adjustable length of separation between blankholder and punch, adjustable length of stroke, pressure and speed, and safety features for making press foolproof.

Press illustrated has 1250 ton capacity with 400 ton third action with bed area of 150" x 72" and a stroke of 66".

Press is installed and operating at the plant of a leading airplane manufacturer.

Clearing Machine Corporation
6499 West 65th Street, Chicago, Illinois

MECHANICAL AND HYDRAULIC PRESSES

CLEARING
MACHINE CORPORATION
CHICAGO

Fairbanks-Morse To Handle P&H Welders

Already in effect, as result of a recent agreement, all Canadian distribution of P&H welders and electrodes, manufactured by the Harnischfeger Corporation, Milwaukee, Wis., will be handled exclusively by The Canadian-Fairbanks-Morse Company, Limited.

The facilities of Canadian-Fairbanks-Morse are well adapted to this new setup. The company maintains branch offices and warehouses in all important cities of Canada, staffed with engineers and service men to insure proper application and satisfactory operation of the equipment it sells.

Chromic-Acid Process of Anodizing

An electrolyte for use in the anodic treatment of aluminum, according to British Patent 537,474, is composed of from 3.5 to 7 percent by weight of chromic acid, 1 to 3 percent of a polyhydric alcohol such as glycerine and an aldehyde such as formaldehyde together with boric acid in a proportion of 0.3 to 0.5 percent. It is also preferable to have present soluble chromates in quantities not exceeding 2 percent.

PUBLICATIONS

The Frederick Post Co. has issued its new **1943 calendar,** featuring a pad **you can see a mile.** It has 52 weekly sheets, built on a war basis with big black numerals that can easily be read from any part of a drafting room. A section of technical data for the engineer and draftsman is included, containing charts on wire and sheet metal gages, screw threads, etc.*

Equipment and procedure for a new, improved and fast method of degreasing and decarbonizing aircraft and other engine parts for overhaul is described in a 16-page booklet recently issued by Turco Products, Inc. **Turco Procedure For Aircraft Engine Overhaul** is the title of the booklet.*

McKenna Metals Co. announces the following new literature: **Bulletin 442 Chip Breaker Designs,** which contains the correct types of chip breakers and how to achieve them for various jobs. It also contains diagrams supplementary to the descriptive materials. **Catalog No. 43 illustrates standard, non-standard and special tools,** contains diagrams which show the correct rake angles for tools made with Kennametal standard blanks. It lists also prices effective October 5, 1942, together with new tool styles and applications.*

Vinylite Wire and Cable Insulation Plastics, is the title of a new booklet by Carbide and Carbon Chemicals Corp., Halowax Products Div., which reviews for electric wire and cable users the important advantages that derive from the use of Vinylite resin compounds for wire and cable insulation from the standpoints of installation, service and safety.*

Haynes Stellite Co., Div. of Union Carbide and Carbon Corp., has issued a new publication **Stellite 98M2 Metal-Cutting Tools for Machining Steel.** It lists the sizes and prices of 84 standard square and rectangular tool bits and of 74 varieties of welded-tip tools all made of 98M2, the recently announced, non-ferrous cutting-tool material.*

Catalog No. 42-A has been issued by **The National Screw and Manufacturing Co.** It is a complete reference book for headed and threaded products, incorporating all current lists available together with the technical and explanatory data found commonly useful. The catalog is bound in loose-leaf style which makes possible the insertion of new pages as changes occur.

A folder on **Solventol,** the new synthetic fluid for metal cleaning and conditioning, has been issued by Solventol Chemical Products, Inc. It contains some interesting information on the use of Solventol in the war program.*

The Norton Co. has issued a new booklet **What's Your Grinding Problem?** a trouble-shooting manual for the grinding machine operator.*

Kempsmith Type G Milling Machines are described and illustrated in a new folder issued by Kempsmith Machine Co. It is Bulletin No. 102.*

A newly developed **load calculator** called the Motorule, which simplifies computing motor horsepower required for metal cutting operations on various machine tools is being offered by General Electric Co.*

Pyrene Mfg. Co. has issued a new folder, **Directions for Inspecting, Recharging and Maintaining Portable Fire Extinguishers,** which is designed to assist in proper maintenance of fire extinguishers.*

The Inside Story of Towmotor is the title of a new manual by Towmotor Co. It is divided into six sections, Design, Frame Construction, Lifting and Stacking Mechanism, Power Plant and Travel Mechanism, Operating and Control Mechanism and Servicing and Maintenance Features.*

The Cincinnati Milling Machine Co. has issued an illustrated folder giving specifications of the **Cincinnati No. 0-8 plain automatic milling machines** which can be equip-

(Turn to page 64, please)

raises roof To Instal Lake Erie Hydraulic Pres[s]

For Speeding Up Army Airacobra Output

Starting with brilliantly conceived design only seven years ago, the success story of the Army P-39 Airacobra is a dramatic tribute to the toil of men and machines of Bell Aircraft Corporation.

Proof that the men of Bell stop at nothing to get things done is shown by the fact that a 300 square foot area of roof was cut away to permit installation of this new Lake Erie Hydraulic Press.

It took eight freight cars to transport this 540,000 pound press from the Lake Erie plant to the Bell factory. The press has a capacity of 5,000 tons and stands over 30 feet high.

A 250 horsepower motor and several auxiliary motors operate the pumping unit.

This is one of the largest aircraft forming presses in America, and Lake Erie is proud of its share in helping increase production of Bell Airacobras for VICTORY.

Daily meetings of executives making up the Lake Erie War Production Board are held for the purpose of speeding up all phases of engineering, purchasing and production of Lake Erie Hydraulic Presses.

The Army P-39 Airacobra built by Bell Aircraft has shown outstanding results in the medium altitude field. The Airacobra carries a 37-mm. cannon. This fighter is in the "over 400 mile-an-hour" class.

(Continued from page 60)
ped either with or without rise and fall spindle carriers.*

Three Data sheets issued by Barber-Colman provide information on the following: **Interlocking Side Mills** of the staggered-tooth type; **Type A Hobbing Machine** and the **No. 3 Hobbing Machine.***

F. J. Stokes Machine Co.'s new catalog on **Standard Molding Presses** describes and illustrates Semi-Automatic Toggle-type Compression Presses, Single Punch and high-speed Rotary Preforming Presses for the plastics industry.*

Ampco Metal, Inc. has issued a new 8-page booklet entitled **Contribution To Victory**, describing pictorially the use of Ampco Metal by War Industries. It contains views of various types of War equipment containing Ampco bronzes as well as pictures of weapons of War made with Ampco-equipped machine tools.*

Aircraft Is Taking Precedence Over Other Military Production

(Continued from page 51)

ing Pratt & Whitney 1200-hp radial air-cooled engines for bombers and cargo planes. Former automotive facilities are taking care of approximately 50 per cent of the engine fabrication, including the forging and machining of major steel sub-assemblies and the forging of some aluminum parts. This engine contains 863 different piece parts and an overall total of 6266 parts.

The newly formed Eastern Aircraft Division comprises five plants converted from automotive to aircraft use. They are the Fisher Body plants at Tarrytown, N. Y., and Baltimore, the Delco-Remy plant at Bloomfield, N. J., the Ternstedt-Trenton plant and the Linden Division, where final assembly takes place. Two Grumman carrier-based planes are being produced for the Navy —the FM-1 Wildcat, a single-place fighter, and the TBM-1 Avenger, a torpedo-bomber capable of carrying a 2000-pound bomb load or a torpedo. Completed planes already are coming off the production line.

Fisher Body Division, which turned out 40 planes per day in World War I, is producing airframe subassemblies for the North American B-25 bomber and also is making parts for the Boeing Flying Fortress.

Cadillac Motor Car Division has been supplying Allison with engine parts since March, 1939, and now manufactures several of the principal components, including the crankshaft, camshafts, connecting rods, piston pins and reduction gears. One of the most difficult parts made by Cadillac is the supercharger rotator vane. Converting this part from hand-made to machine production, Cadillac craftsmen reduced the production time from 125 man-hours to 10 man-hours.

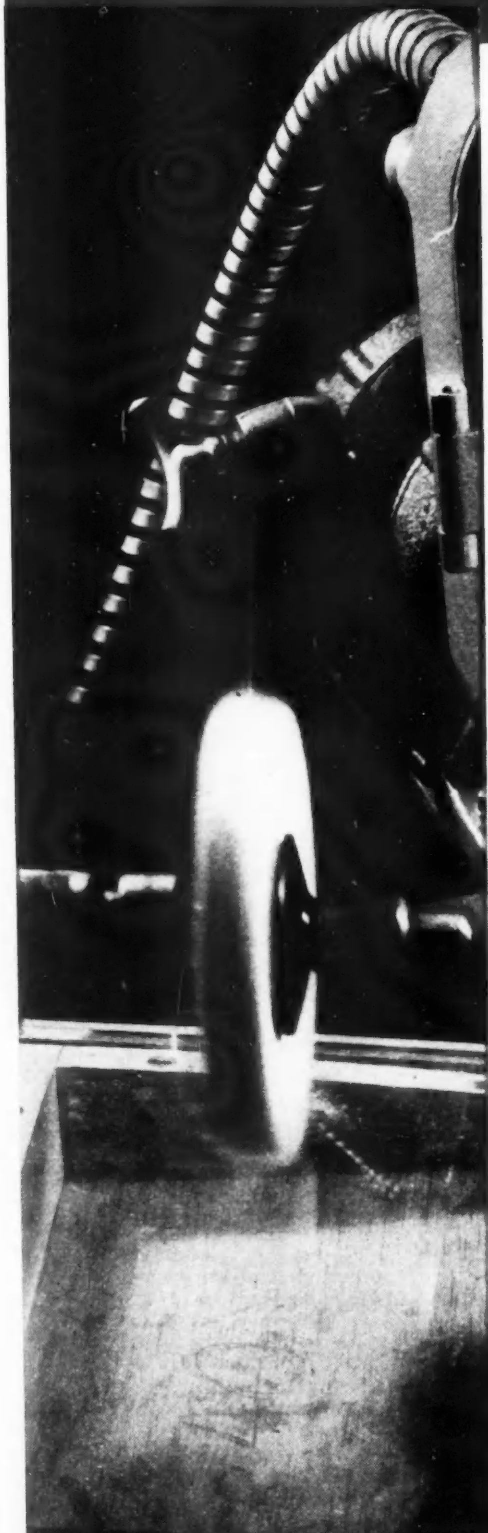
Harrison Radiator Division produces oil temperature regulators, fin-and-tube prestone radiators for liquid-cooled engines such as the Allison, backfire screens and supercharger air intercoolers. The latter originally were made of copper sheets which were bake-soldered, but they were redesigned in aluminum, saving 84 pounds of copper for each unit and adding 52 pounds to the load capacity of the plane. Delco Appliance Division makes the 7-ounce autosyn motors that regulate the dials on the instrument panel control board. Rochester Products Division produces electrical equipment for aircraft installation. Packard Electric Division similarly supplies ignition wire and cable for airplanes.

Delco Products Division makes booster and transfer fuel pump motors for aircraft and landing gear struts for bombers. The inner cylinders for the landing gear formerly were plated with .008 inch of chrome, using one pound of chromic acid per cylinder, and then one-half of this thickness was ground off to make a perfect finish. Delco engineers reduced the chrome coat to .0015 inch thickness and then polished the surface instead of grinding it. This resulted in an 81 per cent saving in chrome and cut the finishing time 37 per cent.

Four GM divisions are manufacturing aircraft cannon and machine guns on a

HOW TO FINISH AND CLEAN

transparent Du Pont "Lucite"



Information for aircraft manufacturers and enclosure suppliers

CRYSTAL clear Du Pont "Lucite" methyl methacrylate resin sheeting is manufactured with a highly polished surface. If the original surface finish is impaired during fabrication or otherwise, proper ashing and polishing will generally restore it.

EQUIPMENT FOR ASHING AND POLISHING

For small pieces of "Lucite" single or double spindle buffing lathes are suitable. For larger parts which are difficult to manipulate portable electric, flexible shaft, or pneumatic machines should be used. Wheels may vary from 6 to 24 inches in diameter. A hard ashing wheel is desirable for preliminary removal of sanding, scraping or filing marks. It should consist of stitched cotton cloth discs without spacers. For polishing and buffing, a softer, unstitched wheel with spacers is needed.

SPEEDS

For ashing, a speed of about 900 f.p.m. is recommended. Polishing wheels can be run up to 2000 f.p.m.

POLISHING

Numerous compounds are suitable. To give a high polish, a final hand buffing operation can be applied with a neutral wax. Most polishing waxes will effectively fill and hide tiny hair scratches, and also provide a protective coating. The plastic or the wheel must be kept moving constantly, to avoid overheating the surface. Remove the polishing compound from the surface by washing after each successive ashing and polishing operation.

CLEANING

The surface finish of "Lucite" is as easily damaged as the finish on a fine car, if wrong methods or cleaning agents are used. Clean off grease and oil deposits with hexane, naphtha, or methanol. Remove fingermarks or light oil with trisodium phosphate dissolved in water. Flush the surface with a mild soap solution, then rub lightly with a grit-free, soft cloth, sponge or chamois.

If a commercial cleaning agent is used, be sure that it does not contain ingredients which might produce crazing.

Practically all leading airplane plants are using "Lucite" in their airplane enclosures because of its clarity, weather-resistance, light weight, and strength. Du Pont also manufactures "Plastacele" cellulose acetate transparent sheeting for light plane, glider and trainer enclosures. Call Du Pont for assistance on questions of forming or fabricating transparent enclosures.

E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, N. J. . . . and 5801 South Broadway, Los Angeles, California.

DU PONT REG. U. S. PAT. OFF. **"LUCITE"** REG. U. S. PAT. OFF.

METHYL METHACRYLATE RESIN

volume basis. They are AC Spark Plug, Brown-Lipe-Chapin, Frigidaire and Oldsmobile. Spare parts also must be shipped with the guns. For every order of 100 Browning 50-caliber machine guns, a total of 9542 pieces must be shipped for replacement purposes if the gun is water-cooled and 3364 pieces if the gun is air-cooled. AC Spark Plug is producing aviation spark plugs and aircraft bearings. Frigidaire is making bomb rack and harness assemblies, auxiliary gas tank assemblies, motor control and hydraulic switches and carburetor bodies.

Aircraft magnetos, ignition harness, pistons and batteries are among the aviation products of Delco-Remy Division. The Delco-Remy foundry is casting aluminum engine blocks and cylinder heads for Allison. Guide Lamp Division is turning out spinner shells for airplane noses and aircraft engine cylinder sleeves. The cylinder sleeves were redesigned by Guide Lamp engineers, substituting stainless steel for aluminum, with a considerable cost saving. Delco Radio Division is making aviation ignition testers. New Departure Division produces aircraft bearings on a quantity basis. Moraine Products Division has replaced prime aluminum with steel in the manufacture of spinner assembly nosepieces. Steel also was substituted for bronze in making the adapter for the spinner assembly.

The new Aeroproducts Division at Dayton, along with Frigidaire, makes propellers. Aeroproducts designed a two-piece hollow steel propeller, saving 100 to 200 pounds of aluminum per propeller and effecting a 75-pound weight saving in the complete assembly. Propellers are one of the restricting factors in the aircraft program. The latest war production report by Donald M. Nelson for September says:

"Plane production may increase in the months ahead more rapidly than propeller production unless propeller output can be greatly increased. Thus far, however, enough propellers have been made to fly all planes."

Airplane production showed a 10 per cent increase in September over August, according to Nelson's report, compared to an overall 7 per cent gain for all munitions. Four-engined bombers came off the assembly lines very nearly on schedule, said the report, while output of all heavy tactical types increased substantially. Light plane output decreased. Ordnance production continued to move slowly and unevenly, advancing 7 per cent for the month. September tank output was up 3 per cent compared to August and production of tank guns was ahead of schedule. Anti-aircraft gun output also was good. Production of ammunition was spotty. Machine tool production climbed 2.4 per cent to $120,118,000 in September. The WPB munitions index for September rose 24 points to 381 and is now nearly four times the December, 1941, base. This index showed a 27-point rise in August.

CMP. Controlled Materials Plan

(*Continued from page* 50)

type and production with both Class A and Class B are to be requested to provide.

The bills of material which have to be got by claimant agencies have to be expressed in terms of steel, aluminum, copper and copper base alloys, the controlled materials. Also, Exhibit I on the plan sets forth other materials which may be required to be shown on the bills. These are: beryllium; cadmium; cobalt, other than as an alloying element; cordage fibers, manila, sisal, jute, istle; magnesium; mercury; mica, other than ground mica; monel metal; nickel, other than as an alloying element; nylon; rayon (high tenacity); rubber, crude, liquid latex, reclaimed, synthetic; tin; tungsten, other than as an alloying element; wood; and zinc.

32 Million Vehicles in 1942

(*Continued from page* 18)

showed them to be 33,695,969 an error on the conservative side of about .04 per cent. While it is somewhat more difficult to estimate the unreported portion of the year at this time, we feel that the figures here given will be within one per cent of the final outcome.

Oil Seals · Dirt Seals · Grease Seals

THE FIFTH IN A SERIES OF MESSAGES TO HELP THOSE ON THE INDUSTRIAL FRONT RESPONSIBLE FOR BETTER BEARING PERFORMANCE

"Perfect" oil seals are made in standard sizes for shafts from $\frac{5}{16}''$ to $1\frac{15}{16}''$, advancing in increments of $\frac{1}{32}''$—from 2" to 5", advancing by $\frac{1}{16}''$—5" to 10", advancing by $\frac{1}{8}''$—from 10" to 11", advancing by $\frac{1}{4}''$—and from 11" to 12", advancing by $\frac{1}{2}''$ increments. For many of these shaft sizes there is more than one standard seal size. Designers are urged to select catalog standard sizes to facilitate delivery and production.

All these seals are finished for a press fit (O. D. tolerances stipulated) into the bearing housing. The housing should be designed where practicable so that the distance the seal travels in being pressed home is not greater than three times its thickness. When this is unavoidable it is well to counterbore the outer portion. Where practicable, the seal should seat against a shoulder.

The wiping lip of the seal is normally turned toward the fluid which it is to seal unless it is more important to exclude the entrance of all traces of foreign matter from outside the bearing, or if the bearing is to be lubricated with grease under pressure.

Call on Chicago Rawhide engineers for advice on any specific sealing problem.

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Aircraft Production Problems Solved by Process Engineering

(*Continued from page* 19)

granular oxidation by reaction of the copper with the aluminum.

Intergranular oxidation converts sound dural to the metal equivalent of wood long exposed to termites, and one can push his finger through what appears to be sound metal. Provided the furnace temperature is accurately controlled, there is only one possible cause of intergranular oxidation, and that is too long a time interval between removal from the heating furnace and full immersion in the quenching bath. Specifications now limit this time interval to nine seconds.

With this requirement in mind, Northrop Aircraft designed and is now using an air furnace mounted over a quenching tank. When the parts are ready for the quench, the sliding doors at the bottom of the furnace are opened and the heat-treat load is dropped through a chute into the water bath in two to four seconds elapsed time. This was the first aluminum heat-treating furnace of its kind in the industry, and it has proved very successful.

Throughout its plant, Northrop Aircraft uses water-soluble forming oil on the friction areas between the sheet material and the dies in drop-hammer and other forming operations. This is much better than the mineral oil formerly used for the purpose, as the oil can be removed from the sheet with cold water. The change eliminated the elaborate degreasing system previously necessary to clean formed material prior to heat treatment. This water-soluble oil is specially compounded for Northrop by one of the major oil companies.

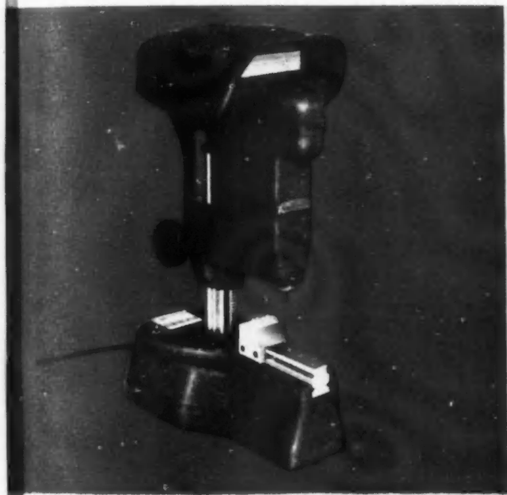
All materials used in the construction of military aircraft must conform to Army and Navy specifications. Before they are used, these materials are tested and examined by various devices such as X-ray and magnetic-inspection apparatus, hardness indicators and mechanical testing machines. Materials are subjected also to visual, physical and chemical analyses, depending on their functions in the complete aircraft.

Aluminum and magnesium castings and forgings are X-rayed for porosity, entrapped oxides, and wall thicknesses. Magnetizable steel parts are given magnetic inspection to detect cracks and flaws which may be many times smaller than a cobweb. Samples from all shipments of leather are analyzed to ascertain whether the leather was salt-, oil-, or chromic acid-tanned. Salt-tanned leather is not recommended for use when in contact with metal, because of its corrosive properties.

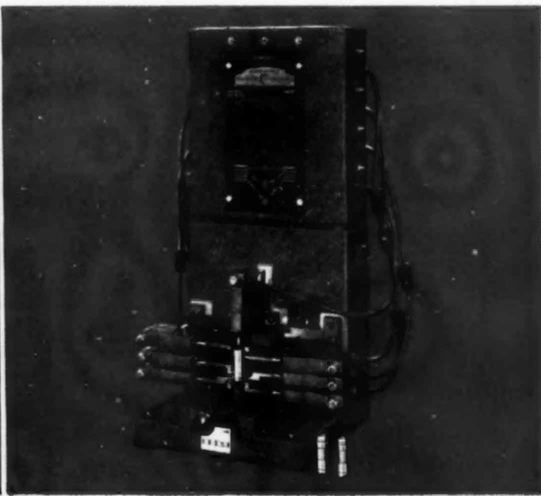
Finishing material such as lacquers, enamels, dopes, primers, etc., and processes such as anodizing, cadmium plating and other chemical treatments are different for all types of airplanes, depending upon the atmospheric conditions they will encounter and the materials used in their fabrication. Finish requirements are more rigid on seaplanes to be exposed to salt-water spray and humid atmospheres than on land aircraft. The different metals used in aircraft require different processing and finishing. Finishes and processes are applied to render the parts corrosion-resistant, for appearance or protection against glare on bright surfaces and for camouflaging.

The fastening processes are very closely controlled by process engineering. All arc, gas, heliarc and spot-welding apparatus are certified periodically and must have Army and Navy approval before certification. The Heliarc welding process (see Sept. 15 issue of *Automotive and Aviation Industries*) was patented and developed by Northrop Aircraft. By this method stainless steel, magnesium and many other alloys, which heretofore were

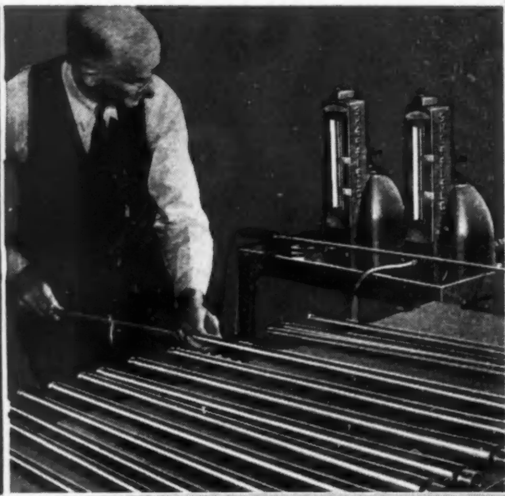
Increase SPEED AND ACCURACY WITH SHEFFIELD PRECISION GAGING INSTRUMENTS



The Visual Gage is available in six magnifications—500, 1000, 2000, 5000, 10000 and 20000 to 1—for checking production and reference gages, work in progress, receiving and final inspection, laboratory and research work. Pitch diameter checked by special attachment.

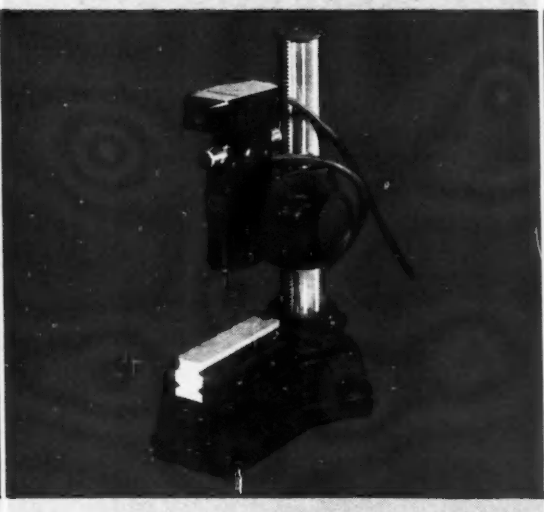


The Multichek is a combination gage which checks simultaneously a number of critical dimensions, indicating by light signals whether each dimension is within, above or below tolerance limits. A master signal integrates all individual signals for maximum checking speed.

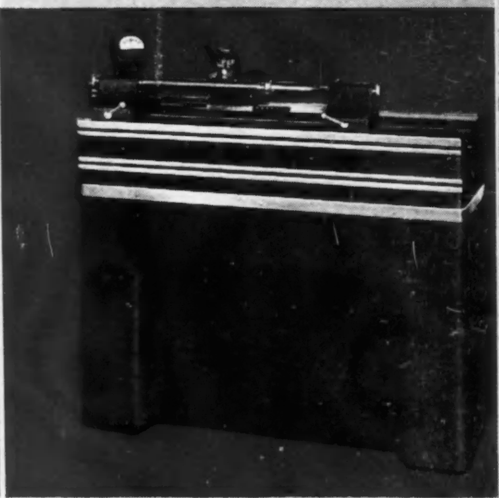


The Precisionaire is an airflow gage for the check ing of internal diameter, taper and out-of-roun on long and/or small bores such as rifle barrel and other relatively inaccessible holes. Th gage may be presented to the work, Mode A, or the work brought to the gage, Model I

The Internalgage checks hole diameter and out-of-round with the same precision as external dimensions are checked on the Visual Gage. It is very advantageous where selective assembly is concerned as in the case of the special piston application illustrated.



The Electrichek is used to show instantly by signal lights whether a dimension is within tolerance, undersize or oversize. It is used as an inspection gage. It can also be mounted on any special fixture desired or directly on a machine to check parts in process or for machine control.



The Thread Measuring Instrument is a com bination electrical and mechanical device fo checking the lead of screw threads or rack teet Precision gage blocks are used as a direct refe ence. A Super-Precision Micrometer facilitate an accurate set-up and the checking operatio

Descriptive literature available upon request

THE SHEFFIELD CORPORATION

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SHEFFIELD GAGES
MASTER GAGEMAKERS

practically impossible to arc weld, may now be welded without the use of a flux. On most metals the welded area is much stronger and more resistant to corrosion than the parent material. Magnesium castings and parts may be repaired by this method with no loss of strength.

Spotweld equipment is checked by periodic shear and microscopic tests. Magnesium alloys are being successfully spotwelded; one magnesium spotweld nugget (see illustration) is capable of supporting a load of over two tons.

As a substitute for the hot alkali-soap baths and hydrofluoric acid formerly used to clean and etch aluminum alloys prior to spot-welding, process engineering introduced a cleaning and etching process calling for only a single cold tank, and this is giving better results than the more complicated old method.

Since metal nameplates are no longer permitted in aircraft construction, because of metal-conservation demands, a substitute in the form of decalcomanias has been developed. This is different from conventional types of decals in that a lacquer or transparent-film backing is not required, nor is the use of cement, glue or varnish for adhesive purposes. The new form of decalcomanias becomes an integral part of the original paint surface, permitting a section to be removed without affecting the rest of the decal.

These new decalcomanias are now being successfully used for all markings and insignia purposes. Those used on the cabin interiors are of the fluorescent type, which are visible with the "black-light" illumination very necessary for instrument panel use. Large insignias ranging to diameters of 42 in. are now successfully used. No coating is required over this type of decal, since they become an integral part of the painted surface.

Gun Turret Development In England

(*Continued from page* 37)

most of these being still on the "secret list," it may be said that the provision of chutes or belt-conveyor tracks for the automatic supply of ammunition from a central magazine has been specified in technical information released by the Air Ministry as a feature to be found in the Halifax II, Stirling and Lancaster four-engined bombers. Mention has been made, too, in official releases of a servo feed, and of the magazine being located near the center of gravity of the aircraft, so making it possible to ensure enough ammunition being available for the most prolonged engagement, a matter of the greatest importance, especially in daylight operations.

As regards prospective developments, it is obvious that, as with the armament of fighters, there will be a tendency in turret design to cater for guns of larger calibre, and if not more guns per turret, then more turrets for larger guns, probably with all-electric operation.

A New Substitute Sheet Metal

A new product has been added to the line of plated metals produced by the American Nickeloid Company, Peru, Ill., electro-plated zinc on steel. The zinc provides a protective coating to the steel base metal, making the sheet resistant to corrosion and rust. The zinc-steel bond forms a coating which is said to be easily workable in manufacture with the result that zinc plated steel can be bent, stamped, formed, drawn, soldered and spot-welded to meet most production requirements.

Electro zinc plated steel is supplied in pre-finished flat sheets which eliminate plating of small parts after fabrication. The zinc coating is said to be proof against cracking or flaking. The new material is available at the present time in sheets only, in sizes up to 36 inches by 96 inches, in a full range of gauges and tempers, in polished, unpolished or satin finishes. The thickness of the coating can be varied to suit individual requirements.

Jig Assembly of Tube Lines for Aircraft

(Continued from page 33)

separator sections of the clamps have been slipped onto the guide posts of the jig brackets. The near end junction plate, like that at the far end, is a permanent part of the assembly and is detached from its brackets when the assembly is removed from the jig.

Hydraulic and instrument line assembly jigs are designed for handy height and ease of access when tilted, as shown in Fig. 2. Braces of varying height present an assembly position identical with that the completed assembly will occupy on the ship. Bridge bracing of the jig frame insures alignment and gives it balance. The ease with which junction nuts can be tightened, regardless of their position, by rotating the jig is obvious. It is so well balanced and of such weight that it will remain without locking in any position desired. Squeeze-locks around the end shafts will hold the frame rigidly for those operations where that is required. Guide posts, permanently mounted on the braces and protruding through the Adel clamps, can be seen in Fig. 2.

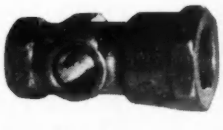
At the inner anchor point, which is shown in Fig. 3, 9 tubes connect to nipples permanently mounted on the anchor plate at the bottom between the two side members of the jig frame. Angles of all nipples are the same as those in the junction boxes on the ship. Two line heads can be seen hanging to the right of the operator's hand. These have no nipple connections because of a recent change in specifications made after the jig was placed in use. Because they are of small diameter and can be easily bent when they are actually connected, it has not been necessary to alter the jig's junction plate. The coupling on the dangling line closest to the camera is still protected by its metal seal cap. One of the advantages of the "wide open" design of the jig is shown here by the ease with which the workman can reach down to the anchor plate to connect couplings.

To complete the nose tunnel hydraulic and instrument line assembly, Adel clamps are closed and tightened and couplings tightened in the end plates. When inspection is finished, bolts that hold the end plates in their brackets will be removed, and coupling nuts fastened to the inner anchor plate will be disconnected and the assembly can be lifted from the jig. It is ready then for transfer to the subassembly department, where it will be fastened into the tunnel provided for it on the lower starboard side of the nose section.

Ease of handling and installing of jig-assembled hydraulic, instrument and other tube lines is shown in Fig. 4 as the 28-tube assembly is pressed into the tunnel provided for it on the lower, starboard side of the big C-47's nose section. The men do the job while sitting on creepers equipped with slanted seats and fold-down back rests, which roll under the lower frame members of the tubular steel frame of the jig in which the nose section is assembled. To attach and connect the 28-line assembly normally takes them one hour. Those two man-hours, plus the two required to assemble the lines in the jig, make a total of four man-hours instead of the 24 man-hours required by the previously used on-the-ship assembly method.

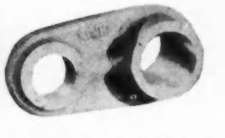
The SUNNEN PRECISION HONING MACHINE

handles jobs like these faster, more accurately, at lower cost

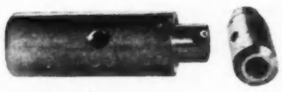


Bronze Valve. The Sunnen method of honing is used to secure a high finish and accuracy.

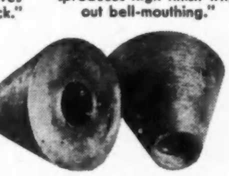
Inner Bearing Ring "Accurately removes last 'tenth' of stock."



Aluminum Aircraft Link "produces high finish without bell-mouthing."

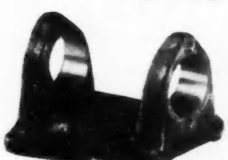


Diesel Engine Fuel Injector Cylinder "So accurate that a piston can be fit within .00005" inch."

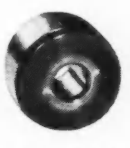


Cones for Wheel Balancing Machine "Accurately align hones two interrupted surfaces."

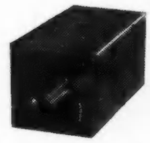
Airplane Engine Parts accurately honed to a super-smooth finish.



"Strict alignment maintained between two holes."



Drawing and Blanking Die "Saves time in producing smooth base metal finish."



Saved time in producing a smooth accurate finish on this bronze remote control valve body.

"Produced an extremely accurate and glass-like finish."

Aviation Hydraulic Cylinder made of Aluminum-Alloy. Improves the quality of the bearing surface. An extremely smooth surface-finish is secured.

Mild Steel Clevis. Honing was used to correct errors of previous machining and maintain true alignment of the two bearing surfaces of this clevis.

Hardened Steel Inner Bearing Race honed to .00005" limit. Surface finish improved; errors of out-of-roundness eliminated.

Aircraft Valve Tappet Roller. 4-Micro finish.

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Giving complete information and showing many examples of use. Or if you prefer, we'll have a sales engineer call and demonstrate this equipment in your plant on your job.

Solve your problems of finishing internal cylindrical surfaces with this inexpensive, yet accurate, honing machine. Relieves big internal grinders for other jobs. Can be set up and work located in a minute. Does not require skilled labor — workers in "teens" can handle jobs in "tenths."

Range .185" to 2.400" — accuracy guaranteed within .0001". Now being used by hundreds of manufacturers handling important war contracts.

Corrects errors of out-of-roundness or taper caused by previous operations. Produces super-smooth finishes. Maintains alignment established by previous operations. Facilitates duplication of sizes.

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Canadian Factory: Chatham, Ontario

SUNNEN

Aircraft Production Meeting

(*Continued from page 48*)

painted similar to aluminum. The sheets are of about twice the thickness of the aluminum sheets they replace.

A molded fuselage door was developed in cooperation with the Glenn L. Martin Co. and is said to embody the same principles of design as the doors of many makes of refrigerator and Panelyte structural flooring. A corrugated or ribbed section is molded, and this section is then vulcanized to a flat paper-base Panelyte sheet. Locks, hinges and handles are securely fastened to the door by riveting in the conventional manner. The door is said to have been well received in assembly plants and to have proven entirely satisfactory in service.

Bearings and Bearing Corrosion

IN COMMON with other high-strength bearing alloys, copper-lead is susceptible to attack by products of oil oxidation. The corrosive attack in most cases results in dissolution of the lead phase and production of a weakened and porous structure of copper. If sufficient lead is dissolved, the porous copper structure is easily crushed, or its bond to the backing metal is weakened, leaving large sections of lead-free copper which may be readily detached from the steel backing. The behavior of copper-lead bearings in the field has been quite erratic, and a knowledge of the critical operating factors should be of value. To data on the subject, the automotive laboratory of Tide Water Associated Oil Co. ran comparative tests on coarse and fine-structure copper-lead bearings. A paper dealing with the test methods and the results obtained was presented by Leonard Raymond of the Laboratory.

Bearing tests were made in a three-cylinder, two-stroke Diesel engine developing 82 bhp at 2000 rpm. This engine employs oil cooling to maintain proper piston temperatures, and the oil temperatures are relatively high, despite the use of the cooler. The bearings used as standard equipment are of coarse structure; the fine-structure bearings were specially manufactured for this investigation. Engine tests of 500 hours' duration, in which one standard coarse-structure connecting rod bearing was replaced by a fine-structure bearing, were made at a controlled oil-base temperature of 230 F. A variety of commercial and experimental oils were run.

The results showed little difference in the weight losses due to corrosion by the two bearing types respectively, although there was a slightly smaller loss in the case of the fine-structure bearings. A series of 100-hour runs were then made at 260-F oil-base temperature (30 deg higher), all other conditions remaining the same. In these runs the fine-structure bearings proved definitely more corrosion-resistant than the coarse-structure bearings. The surface of the fine-structure bearings after use was a dull brown, while the coarse-structure bearings had a coppery appearance. In the case of the coarse-structure bearings, the increase in the amount of metal lost due to an increase of 30 deg in the oil temperature was greater than that due to a five-fold increase in the time of operation. In addition to being more corrosion-resistant, the fine-structure copper-lead also has higher mechanical strength, which is of special importance where operating temperatures are high.

Survey of Non-Critical Materials

THE subject, "Non-Critical Materials for Aircraft Construction," was discussed by L. D. Bonham of Lockheed Aircraft Corp. He pointed out that low-carbon steel sheet can be used for many purposes for which stainless steel and aluminum alloys have been used in the past. Where extreme corrosion or heat-resistance is not essential, as in fire walls, exhaust shrouds, ammunition boxes, trays and chutes, low-carbon

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Seven days a week you are doing one of the greatest jobs of production the world has ever known. We see one part of that job here at Alcoa where, in great plants, over seventy thousand workers are producing Aluminum in quantities that were mere fantasy yesterday.

But there's an eighth day tucked in among the few open spaces in the seven-day week. Engineers are able to squeeze in some important Imagineering about automobiles—about post-war planning that will help convert war jobs into peace jobs.

Imagine what 1000 pounds less weight in an automobile would mean in performance, gas economy and tire life. Then engineer it down to the realization that 1000 pounds *can* be taken off by using, say, 500 pounds of Aluminum per car. Aluminum costs less today. New methods, techniques, processes and new forms of metal coming out of the war effort will all be available for the as-yet-untold possibilities in tomorrow's peacetime cars.

Our eighth day is devoted to helping Imagineers throughout industry use the potentialities of Alcoa Aluminum in bettering the new products they are dreaming up.

Alcoa engineers want to work with you on tomorrow's problems as well as today's. Aluminum Company of America, 2110 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA ALUMINUM

sheet steel can be satisfactorily substituted for stainless.

Where sheet steel is used for airframe parts, the problem of protection against corrosion is rendered difficult by the fact that spot-welding is so largely used as a joining method. If the parts were riveted together, they could be zinc- or cadmium-plated, painted and then assembled. A search is now being made for a method of pretreating the material that will provide protection against corrosion and will not interfere with the spot-welding operation. Cadmium-plated sheets can be spot-welded satisfactorily, but the process presents a certain health hazard, as poisonous cadmium oxide fumes are generated. Zinc-plated sheet cannot be satisfactorily spot-welded, because zinc-contamination of spot welds results in brittle weld areas. Various chemical treatments have been devised for protecting steel parts against corrosion. They form an iron-phosphate, zinc-phosphate or iron-hydroxide film on the surface of the material. However, unless the coating formed is extremely thin, it makes spot-welding difficult, due to the high electrical resistance between contacting surfaces.

Some experimental work has been done looking to the use of aluminum-clad low-carbon steel sheet for fire walls. The aluminum cladding has greater corrosion resistance than the core metal, and the material is reasonably satisfactory, the only objection being that the aluminum layer will sometimes crack in forming operations. Efforts are now being made to increase the ductility of the coating.

In order to conserve aluminum, the aircraft industry in many instances has replaced it by carbon steel, magnesium, wood and plastics. Airframe manufacturers can conserve copper by substituting aluminum alloys having relatively small copper contents, such as 61S (0.25 per cent) for 24S (4.5 per cent). The two materials, of course, are not exact equivalents mechanically, but in many applications the substitution can be made, and sometimes even with advantages other than that of copper conservation.

Plastics have long been used by airframe manufacturers to a limited extent, but only for such parts as pulleys, clamps, guides, electrical equipment items and miscellaneous interior parts. The critical shortage of certain metals has forced airframe manufacturers to consider the use of plastics in the form of sheets, bars, tubes and molded articles.

A shortage of the chemicals entering into organic finishing materials has forced airframe manufacturers to resort to substitutes of a less critical nature. Toluene, for instance, has been almost universally used as one of the thinners for primers and lacquers. Its importance as a basic material in the manufacture of explosives has necessitated its replacement by other solvents, such as naphtha and certain of the alcohols.

The use of natural rubber in the manufacture of airframes has been discontinued, except for tires, tubes and vibration dampers. Even these latter items will shortly be made of synthetic rubber. The use of (natural or synthetic) sponge rubber for arm rests, pads and cushions has been practically eliminated. The need for synthetic rubber can be minimized by using such substitutes as felt and bound hair.

For the first time in the history of aviation, impregnated wood and plywood are being used to conserve critical metallic materials. Wood construction was used during the first world war, but not as a conservation measure. Wood construction is now being considered, and is being used by all airframe manufacturers in order to assist in relieving the shortage of critical metallic materials. The use of plywood construction is playing a vital role in the trainer plane and glider program.

A New Vee-Belt

THE Goodyear Tire & Rubber Company, Akron, Ohio, have developed a new V-belt which is said to be especially efficient in armored tanks, where lack of ventilation causes belts to run at excessive temperatures. Endless steel cords are used in these belts to avoid stretch or breakdown under severe conditions.

Buick's Know How Speeds Production of Engine Parts

(*Continued from page 25*)

rough forging comes in at 175 lb, is whittled down to but 75 lb. In preparation for machining the forging is upset in an Ajax machine, normalized and drawn, then centered at both ends. As in the case of the crankshaft, the end of the forging is cut off into a coupon and test wafer on a Campbell Cutomatic, the test coupons being suitably machined. These test pieces follow the part through all of the operations, leaving a permanent metallurgical record. Both ends are centered on a Sundstrand double-end centering machine.

Initial turning operations, in several stages, are handled in Fay automatic lathes. Sundstrand type A automatic lathes are employed for rough turning the diameters on the front and rear ends. The 2-1/16 in. diameter hole through the shaft is core-drilled in a W. F. & John Barns deep hole drilling machine, while the front end is step-core-drilled in a similar machine. The work then is washed in preparation for heat treatment, heated in a General Electric box-type furnace, quenched in oil, drawn in a G.E. furnace at about 870 deg F for three hours, and sand-blasted in a Pangborn cabinet. Following heat treat, the shaft is centered and faced at both ends in a Sundstrand centering machine; then turned, and re-centered at both ends in Monarch lathes. One of the most unique operations found here is the finish-turning of the rim in a Monarch lathe fitted with a Keller automatic attachment, permitting the cutting tools to finish surfaces in three different planes in the same setting.

Now the shafts are fitted with special arbors having unusually small centers which are said to permit of accurate alignment for rough grinding. Rough grinding is done in various stages in Norton and Landis grinders, including both cylindrical and special angular head machines.

Next come the drilling and reaming of 6 large holes in the web, using for this purpose a Natco two-way angular drilling machine; then the drilling of 12, 1-13/16 in. holes in the web on special two-spindle Barnes Drill Co. machines. The specially formed windows in the web are trepanned in Pratt & Whitney Keller profiling machines. Front and rear sides of the rim now are scalloped in Fellows 7-A gear shapers; while twelve flats are milled on the outside of the rim on Cincinnati Duplex Hydromatic mills.

Still another unique trick is the turning of the formation of the spoke on the front and rear sides in separate settings in Monarch lathes fitted with Keller automatic tracer attachments. This is supplemented with various blending milling operations on Cincinnati vertical milling machines.

Finish grinding operations on various bores are handled on a battery of Heald and Bryant internal grinders. Here, too, is a special operation in which a taper bore is ground on Bryant grinder fitted with a taper attachment.

The foregoing bears only on the initial operations. In preparation for final finishing the shafts again are fitted with special arbors for finish grinding, and go through successive operations on Landis and Norton grinders of plain and angular head types. All of the finish-grinding operations are held to close tolerances, an example of this being the grinding of a 3.958 in. diameter which is held to plus 0.000 minus 0.0007 in. Following grinding, the shafts are washed in a Blakeslee machine, degreased in a Detrex machine, then Magnafluxed and inspected, using Sheffield gages.

Now comes a succession of precision-

boring operations on Heald Bore-Matics, using Carboloy-tipped fly cutters; and numerous drilling and reaming operations. Splines are produced by milling in Sundstrand Rigidmills; the internal thread is cut either on Lees-Bradner thread millers or on an Ex-Cell-O precision thread grinder. The external thread is cut from the solid diameter on an Ex-Cell-O precision thread grinder.

Complete in every detail as to machining, the work proceeds to the polishing room for an exhaustive schedule of burring, filing, and polishing with Kellerflex tools and Thor rotary air drills. This is followed by washing and Magnafluxing. The diameters are finish-lapped in a Norton Micro lapping machine. Shafts now are subjected to a 100 per cent inspection of all dimensions, the Pratt & Whitney Electrolimit gage being used extensively for this purpose.

It is evident from the foregoing that precision grinding operations of every description characterize the machining of crankshafts and propeller shafts. It is important to note that the secret of the successful maintenance of dimensional tolerances and the formations produced by the wheels is tied in with certain basic factors including — the character of the machine itself, the proper selection of wheels, and finally, the use of unique wheel dressing attachments fitted with carefully selected industrial diamonds.

Space does not permit us to do full justice to the departments devoted to the manufacture of master rods and link rods. How extensive these operations are, may be judged from the fact that they occupy the entire building formerly devoted to the manufacture of Buick engines. Suffice it to say that Buick has so lined up these departments as to take full advantage of modern equipment and mass production methods.

The major part of the operations on the rods is done on milling machines of various types and makes, including Sundstrand Hydro-Screw Rigidmils, Kearney & Trecker vertical mills, Cincinnati tracer-controlled Hydromatics, Cincinnati four-spindle Hydrotels for milling the channel section, and other types of Cincinnati milling machines. On the link rod, we find a great variety of Barnes Drill Co., Hydrams and Barnes drills on the precision drilling of the large holes. An interesting innovation is the use of Fellows gear shapers for forming the large and small ends of the rod.

Sides of rods are ground in Mattison grinders, holding 16 rods at a time in the fixture. Outstanding among the surface grinding set-ups is that of form-grinding the boss ends of the rod. The rods are held in a fixture, 16 at a time as before, the fixture being reciprocated under a specially grooved wheel to provide the proper formation. Bryant internal grinders are very much in evidence, being used for finish-grinding various bores. A battery of Barnes Drill Co. single-spindle honing machines fitted with Micromatic fixtures and tools is employed for honing the large and small ends of the rods.

Following honing, the link rods are degreased in a Detrex machine, Magnafluxed, degreased again, and inspected. Final operation is that of pressing-in the bushings at both ends, then precision-boring them in a two-spindle 48-A Heald Bore-Matic, fitted with Carboloy-tipped fly cutters. It is of interest to note that the honed bores, prior to pressing-in of the bushing, are checked for size with the new Sheffield Precisionaire gage.

Needless to say, the operations on the master rod are even more extensive not only because the part is larger and more intricate in form but also because of the two-piece construction in which both the rod and cap are involved. In the main, however, the same kind of equipment is employed as has been noted so briefly in the foregoing.

Although this study has been made extremely brief, for many good reasons, we believe that the carefully selected pictorial section will give readers an excellent visualization of the general character of the machine shop as well as a better appreciation of the types of equipment employed here.